Chapter Five: Reasonably Foreseeable Effects of the Beaufort Sea Areawide Sale

Contents

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This chapter and the one following describe the ways in which the sale may affect the environment and its people. Key to understanding the potential for effects lies in understanding the culture, communities, and economy of the North Slope Borough (Chapter Four). Equally important is knowledge of the surrounding natural environment (Chapters Two & Three).

Section A of this chapter describes current methods of oil and gas exploration, development and production in the Arctic. Transportation and accidental discharge of oil and gas are specific issues described in Chapter Six. Section B analyzes effects of oil and gas activities on historic resources, subsistence uses, and fish and wildlife populations of the sale area. Sections C and D discuss the reasonably foreseeable effects on municipalities and communities, and fiscal effects. This chapter combines current knowledge of oilfield development impacts in the Arctic with the past, present, and reasonably foreseeable future effects of oil and gas lease sales.

Potential bidders begin the process by weighing the costs and benefits of obtaining and keeping the lease. They acquire and analyze existing data, conduct geophysical exploration, estimate the volume and type of recoverable reserves, estimate the cost of developing reserves, and attempt to calculate the expected return on their investment. These considerations may be weighed in light of other factors, such as the state's leasing policy, schedule of future sales, or competing projects in other parts of the world. Considering all these variables, it is not possible to predict which tracts will be leased.

Strategies used to explore for, develop, produce, and transport potential petroleum resources will vary depending on factors unique to the individual tract, lessee, operator, or discovery. If a commercially developable deposit is found, any development would require construction of one or more platforms or drilling pads. Construction of onshore or offshore pipelines would be likely, and other production and transportation facilities would also probably be necessary. Some new roads may also be required, and machinery, labor, and housing would be transported to project sites.

The state of Alaska as a whole, the NSB, and the communities of Nuiqsut, Kaktovik, and Barrow may experience effects of activities following this sale in both monetary and non-cash terms. Local impacts might be significant. Potential effects might include:

- Erosion
- Water quality changes
- Use conflicts
- Chemical/pollutant releases
- Disturbance to wildlife
- Impacts to human built environment
- Oil spills
- Air quality degradation
- Alteration of hydrology
- Siltation
- Loss of fish and wildlife
- Employment opportunities
- Increased noise and traffic
- Road, dock, airstrip, sanitary & utilities construction
- Habitat loss or change
- State petroleum tax & royalty revenues
- Environmental studies
- Local oil and gas property tax revenues

Most adverse effects are temporary and might occur during development, and not during exploration and production phases. Positive effects occur at all phases and fiscal benefits of petroleum extraction may last several decades. All lease-related activities are subject to applicable local, state, and federal statutes, regulations, and ordinances, and subject to lease mitigation measures. Implementation of any exploration and development program must meet the requirements of regulatory agencies prior to approval. Permit requirements must be evaluated in light of the particular activity proposed, and plans of operation must be approved with appropriate project-specific and site-specific safeguards.

DO&G has developed general mitigation measures to minimize pollution and habitat degradation, and disturbance to fish and wildlife species, subsistence uses, and local residents. Additional project-specific and site-specific mitigation measures will be applied to particular exploration and development proposals as additional information becomes available. Despite these protective measures, some impacts may occur. In this chapter, potential impacts are discussed, and measures to mitigate future impacts are summarized. For a full text listing of sale mitigation measures see Chapter Seven.

A. Post Lease Sale Phases

Lease-related activities proceed in phases; each subsequent phase's activities depend on the completion or initiation of the preceding phase. Table 5.1 lists activities that may occur during these phases.

Table 5.1 Activities That May Be Found At Post Lease Sale Phases

	Offshore	Onshore
Exploration	water usage permitting monitoring environmental studies seismic tests exploratory drilling rigs ice islands & ice roads gravel islands drilling muds and discharges marine vessel support helicopter access worker camps bottom founded drilling facilities	water usage permitting monitoring environmental studies seismic tests exploratory drilling rigs ice roads & ice pads drilling muds gravel pads (rare) worker camps increased air traffic marine vessel support
Development	permitting monitoring environmental studies research and analysis onshore facility construction dock and bridge construction subsea pipelines drilling rigs increased air and vessel traffic gravel pits gravel island construction air emissions	permitting monitoring environmental studies research and analysis gravel pits, pads and roads dock, bridge, and facility construction pipelines drilling rigs work camps increased air and vessel traffic air emissions
Production	permitting monitoring drill programs reinjection wells: gas and sea water submarine structures or anchors support infrastructure produced water injection air emissions pipeline maintenance worker camps waste disposal	permitting monitoring well heads injection wells: gas and sea water well work-over rigs gravel pads and roads produced water injection air emissions pipeline maintenance work camps support infrastructure

1. Exploration

The purpose of exploration is to gather as much information about an area as possible. Some of these activities take place before the lease sale as prospective bidders evaluate the offered acreage. However, most extensive exploration operations occur after a lease is obtained.

Onshore and offshore exploration activities may include the following: research and monitoring, examination of the surface geology, geophysical survey programs, researching data from existing wells, performing environmental assessments, and the drilling of an exploratory well. Surface analysis includes the study of surface topography or the natural surface features of the area, near-surface structures revealed by examining and mapping exposed rock layers, and geographic features such as hills, mountains and valleys.

Exploration of offshore areas is more difficult since scientists cannot explore the sea bottom in person. They must use a variety of remote-sensing means to gather the necessary information about the area of interest. Side-scan sonar, fathometer recordings, shallow coring programs and geophysical surveys are tools often used in marine exploration programs.

a. Geophysical Exploration

Geophysical exploration on the North Slope and in the Beaufort Sea has been ongoing for several decades. Geophysical surveys are not considered to be lease-related activities, since they normally are conducted prior to a lease sale. Surveys conducted following a lease sale are not confined to a lease, and there is no restriction as to who may conduct a survey.

Geophysical surveys help reveal what the subsurface looks like and help locate subsurface hazards. The geophysical survey process involves sending energy into the earth or using an energy wave generating method, such as Vibroseis onshore or on ice, and air guns in open water. These sources generate the energy waves that bounce back from the various rock layers and are received and changed into electrical impulses by sensory devices called geophones (on the land and ice) and hydrophones (in water). The impulses are recorded on computer tape, processed on high speed computers, and displayed in the form of a seismic reflection profile. Geophysicists then analyze the profile to determine subsurface features. Another source of energy includes using explosive charges, however this method has largely given way to the Vibroseis method, and their use on the North Slope is rare.

Geophysical exploration activities are regulated by 11 AAC 96 and permits are tailored specifically for each project. Restrictions on geophysical exploration permits depend on the duration, location and intensity of the project. They also depend on the potential effects the activity may have on important habitat and species, such as caribou and waterbirds. The extent of effects on important species varies depending on the survey method and the time of year the operation is conducted. Onshore surveys are only allowed during the winter months after there is sufficient snow cover, and the ground is frozen to at least a foot deep. For offshore surveys, seasonal restrictions are in effect so as not to affect subsistence whale hunting (See Chapter Seven).

Offshore exploration equipment includes seismic vessels, ice breakers, support vessels including aircraft or helicopters. Operations are conducted between April and October during open water. Geophysical surveys on water use a ship to tow an airgun or an array of several airguns to generate the energy source needed. Airguns contain chambers of compressed air and are towed directly behind the ship at a depth of about 30 to 40 ft.. The airgun injects a bubble of highly compressed air into the water. This sound is reflected from the rock layers beneath the sea floor and picked up by hydrophones, the marine version of geophones. The hydrophones may be towed or placed on the water bottom where they remain stationary while the seismic boat moves over them. The data are handled in the same manner as onshore geophysical surveys. For offshore surveying, MMS estimates that site-specific seismic surveys would cover an approximate area of 23 square km for each exploration or delineation well, and would occur over a 2 to 5 day period (MMS, 1996: IV.A-2).

Standard permit conditions for North Slope seismic operations are designed to protect resource values and ensure compliance with the Alaska Coastal Management Program. Vehicle maintenance, campsites and/or storage and stockpiling of material on surface ice of lakes, ponds, or rivers is prohibited. To avoid additional freeze-down of deep-water pools harboring overwintering fish, watercourses shall be crossed at shallow riffle areas from point bar to point bar. Compaction or removal of the insulating snow cover from the deep-water pool areas of rivers must be avoided.

b. Exploration Drilling

If the geophysical surveys indicate the possibility that oil or gas accumulations may be present, the lessees may initiate the drilling of an exploration well. Drilling is the only way to learn whether or not commercial quantities of oil or gas are present in the rock formations beneath a lease. Exploratory drilling happens after the lease sale (after mineral rights have been secured) and after preliminary, less expensive, exploration activities reveal the most likely places to find oil or gas.

Onshore exploratory drilling operations must occur in winter (generally between December and May) to minimize impact. Ice roads on land-fast ice or onshore provide access to sites. Sea-ice roads are used between January 1 and April 15 and are designed to support anticipated loads. In extraordinary circumstances, permanent roads made of sand and gravel laid over undisturbed ground may be permitted. The drill site is selected to provide access to the prospect to be drilled and, if possible, is located to minimize impacts to sensitive areas. The ice pad supports the drill rig which is brought in and assembled at the site, a fuel storage area, and a camp for 50 to 60 workers. If the facilities are not available, a temporary camp of trailers on skids or wheels may be placed on the pad. These roads have weight restrictions usually dependent on ice thickness. For a discussion of the potential impacts of ice pads on tundra, see Section B.

An exploratory drilling operation generates approximately 12,000 cubic ft. of drilling solids. The state discourages the use of reserve pits and most operators store drilling solids and fluids in tanks until they can be disposed of, generally down the annulus of the well, in accordance with 20 AAC 25.080. In many circumstances, the cuttings are transported to a grind and inject facility. If necessary, a flare pit may be constructed to allow for the safe venting of natural gas that may be encountered in the well. If the exploratory well discovers oil, it is likely that the pad used for the exploratory well will also be used for production testing operations.

Exploratory drilling generates more information for the lessee. Drilling operations collect core samples, well logs, cuttings, and various test results. Cores may be cut at various intervals so that geologists and engineers can examine the sequences of rock that are being drilled. Well logs are records of tests conducted by lowering various instruments into the well bore. Cuttings are fragments of rock cut by the drill bit.

The fluids pumped down the well are called muds, and different formulations are used to meet the various conditions encountered in the well. Muds are naturally occurring clays and small amounts of biologically inert products. They cool and lubricate the drill bit, prevent the drill pipe from sticking to the sides of the hole, and seal off cracks in down-hole formations to prevent the flow of drilling fluids into those formations, and carry cuttings to the surface. (ARCO, Undated: 80-84, Gerding, 1986: 97-174)

The drilling process is as follows:

- Special steel pipe, conductor casing, is bored into the sea floor offshore or soil onshore.
- The bit rotates on the drill pipe to drill a hole through the rock formations below the surface and into the lease.
- Blowout preventers are installed on the surface and only removed when the well is plugged and abandoned. Blowout preventers are large, high-strength valves which close hydraulically on the drill pipe to prevent the escape of fluids to the surface. (ARCO, Undated: 80-84)

Progressively smaller sizes of steel pipe, called casing, are lowered into the hole and cemented in place to keep the hole from caving in, to seal off rock formations, seal the well bore from groundwater, and to provide a conduit from the bottom of the hole to the drilling rig.

If the exploratory well is successful, the operator will probably drill one or two more wells to delineate the extent of the discovery and gather more information about the field. The lessee needs to know how much oil and gas may be present, their quality, and the quality of the rocks in which they are found, to determine whether or not to proceed to the development phase.

The extent and location of offshore exploratory and delineation drilling depends on petroleum potential, water depth, sea-ice conditions, ice-resistant capacity of drilling units, and drill rig availability. The offshore portion of the sale area is in less than 20 m of water. Artificial ice islands may be employed as drilling platforms in less than 15 m of water, and their construction and supply would be supported by ice-roads. In depths greater than 10 m., bottom-founded structures would likely be employed to support drilling operations. Gravel islands, constructed in winter, could be employed for exploratory and delineation drilling activities in nearshore waters. Gravel would come from an onshore location and be transported to the site via ice road. Such operations would be supplied by vessels during the open water season (BPX, 1996). See Appendix E for more detail on directional and extended-reach drilling.

2. Development and Production

The development and production phases are interrelated and difficult to distinguish; therefore, this section discusses them together. During the development phase, the operators evaluate the results of exploratory drilling and develop plans to bring the discovery into production. Production operations bring well fluids to the surface and prepare them for transport to the processing plant or refinery. These phases can begin only after exploration has been completed and tests show that the discovery is economically viable. (Gerding, 1986: 177-199)

After designing the facilities, the operators construct permanent structures and drill production wells (See Figure 5.1). The operator must build production structures that will last the life of the field and may have to design and add new facilities for enhanced recovery operations as production proceeds. Gravel pads (onshore) and gravel islands (offshore) are common permanent structures used for production facilities.

The development "footprint" in terms of habitat loss or gravel filling has decreased in recent years as advances in drilling technology have led to smaller, more consolidated pad sizes (Figure 5.2). A single production pad and several directionally drilled wells can develop more than one and possibly several 640-acre sections. Unless pool rules (oil or gas field rules governing well drilling, casing, and spacing which are designed to maximize recovery and minimize waste) have been adopted under 20 AAC 25.520, existing spacing rules stipulate that where oil has been discovered, not more than one well may be drilled to that pool on any governmental quarter section (20 AAC 25.055(a)). This would theoretically allow a maximum of four well sites per 640-acre section. Where gas has been discovered, not more than one well per section may be drilled into the pool. See Appendix E for more detail on directional and extended-reach drilling.

Between construction of the Prudhoe Bay oilfield complex (1971) and 1991, the following reductions in the development footprint have been made on the North Slope:

- Spacing between wellheads - reduced 91-percent.
- Surface area of gravel development pads - reduced 76-percent.
- Surface area for a contractor service area - reduced 95-percent.
- Gravel roads for pipeline construction - eliminated.
- Ice pads used in lieu of gravel pads for exploratory wells.
- Underground injection for disposal of drilling fluids, muds, and cuttings.
- Design and permitting of centralized waste management facilities yielding a 95-percent recycling of all associated wastes.
- Fewer drillsites needed due to advances in directional drilling.
- Reserve pits eliminated or needed only on a temporary basis.

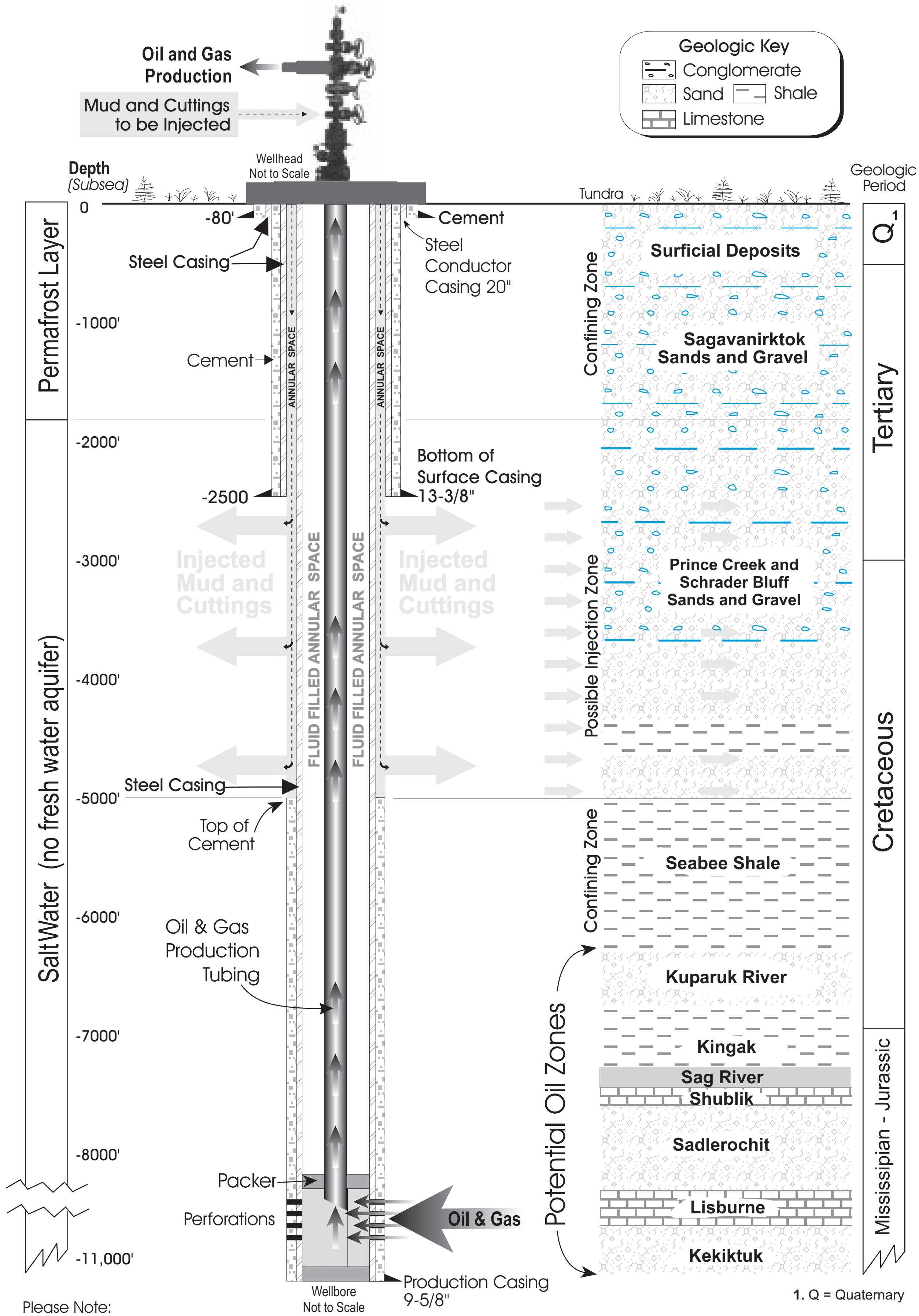
Reductions in pad size, wellhead spacing, and facility consolidation continue to be made, further reducing environmental effects. Additionally, advances in drilling technology have made development of oilfields possible from just one or two pads. For example, the 375 million barrel Northstar field will be developed from a single gravel island. The 120 million barrel Badami oilfield is producing from a single drillsite pad and one facility pad. The 365 million barrel Alpine oilfield will be developed from two pads, and the Liberty oilfield will be developed from a single gravel island.

Onshore development facilities would use gravel pads, and offshore facilities would likely be sited on enhanced existing gravel islands or manmade gravel islands. Both onshore and offshore facilities will likely include several production wells, water injectors, gas injection wells, and a waste disposal well. Wellhead spacing may be as little as 10 ft. A separation facility would remove water and gas from the produced crude, and pipelines would carry the crude to TAPS. Some of the natural gas produced is used to power equipment on the facility, but most is re-injected to maintain reservoir pressure. Produced water is also reinjected. Often, sea water is treated and injected into the reservoir in order to maintain pressure, improve recovery, and replace produced fluids. Produced water is treated to remove sand and other particles. Sea water is filtered to remove solids and dissolved oxygen.

Offshore Drilling Technologies	
Type	Water depth limitations & season used
Bottom founded steel caissons	>10 m depth, year round
Gravel islands	<15 m depth, year round
Ice islands	hard pack ice, winter only

Drilling activities offshore in summer months when the ice pack is offshore are highly dependent on weather conditions. They are also dependent on restrictions designed to avoid potential conflicts with marine mammal migration, fish migration, or subsistence use (BPX, 1996) All marine discharges must comply with NPDES permitting requirements. The preferred method of muds and cuttings disposal is via re-injection. Reinjection of drilling muds and cuttings is the preferred disposal method, and must comply with the requirements of the Underground Injection Control (UIC) program administered by the AOGCC.

FIGURE 5.1 Typical Production/Injection Well (North Slope, Alaska)



Please Note:
1. When injection phase is completed, the 9-5/8" X 13-3/8" annular space is pumped full of cement and permanetly sealed.
2. Casing size and setting depths are approximate.
3. In the Kuparuk River Unit the surface casing is set through the West Sak interval (to approximately -4000' ss).

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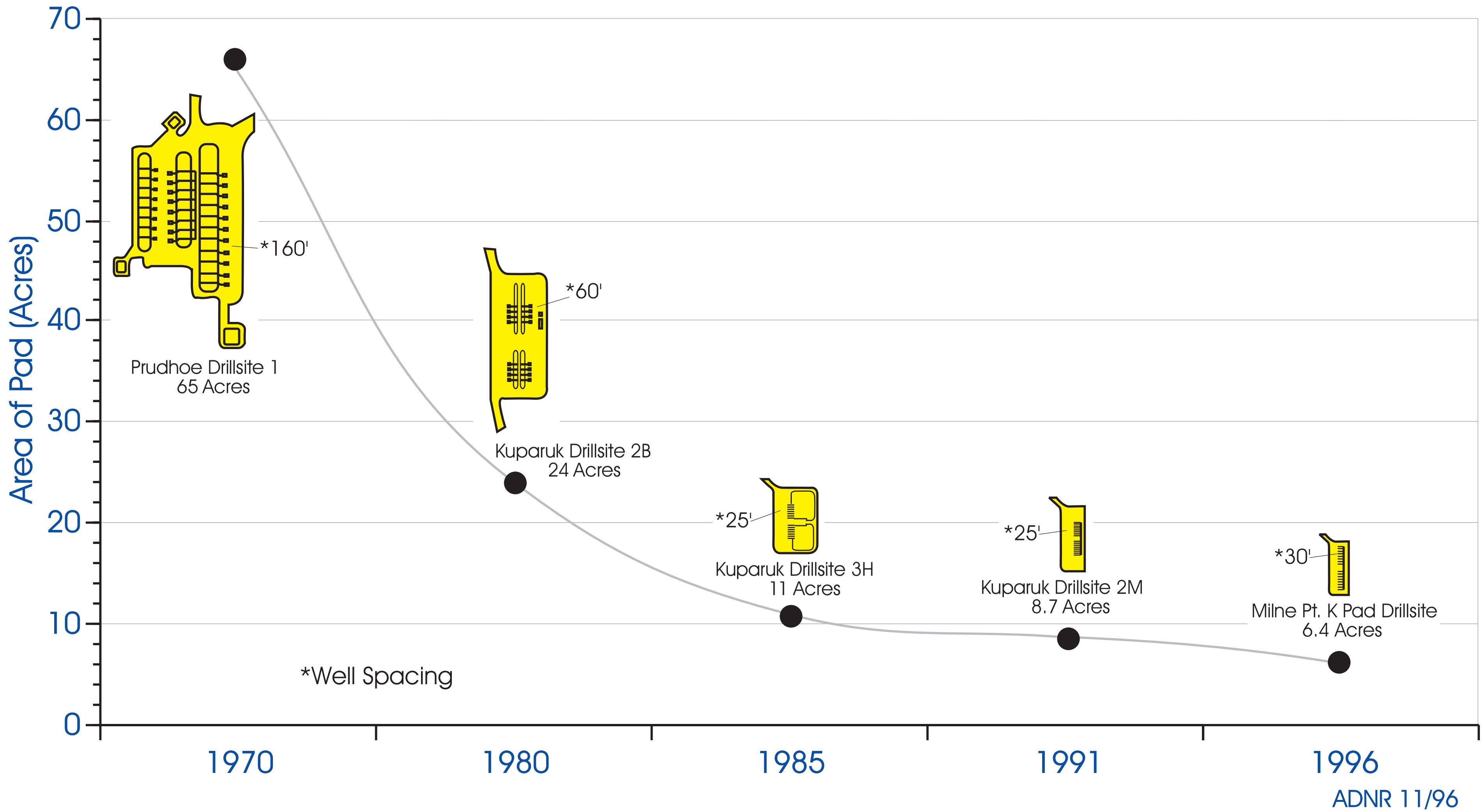
FIGURE 5.2 Evolving Consolidation of North Slope Production Pad Size



B. Cumulative Effects

Consideration of cumulative effects recognizes that industry activity in the sale area may never proceed beyond the exploration phase. It is impossible to predict whether a commercial discovery of oil or gas will ever be made. Development will not occur unless a commercial discovery is made, engineering, economic, and environmental assessments are completed, and permits are scrutinized and approved by agencies. It is anticipated that exploration activities will be conducted during winter, but effects of development, production, and transportation are evaluated as if they occurred year-round.

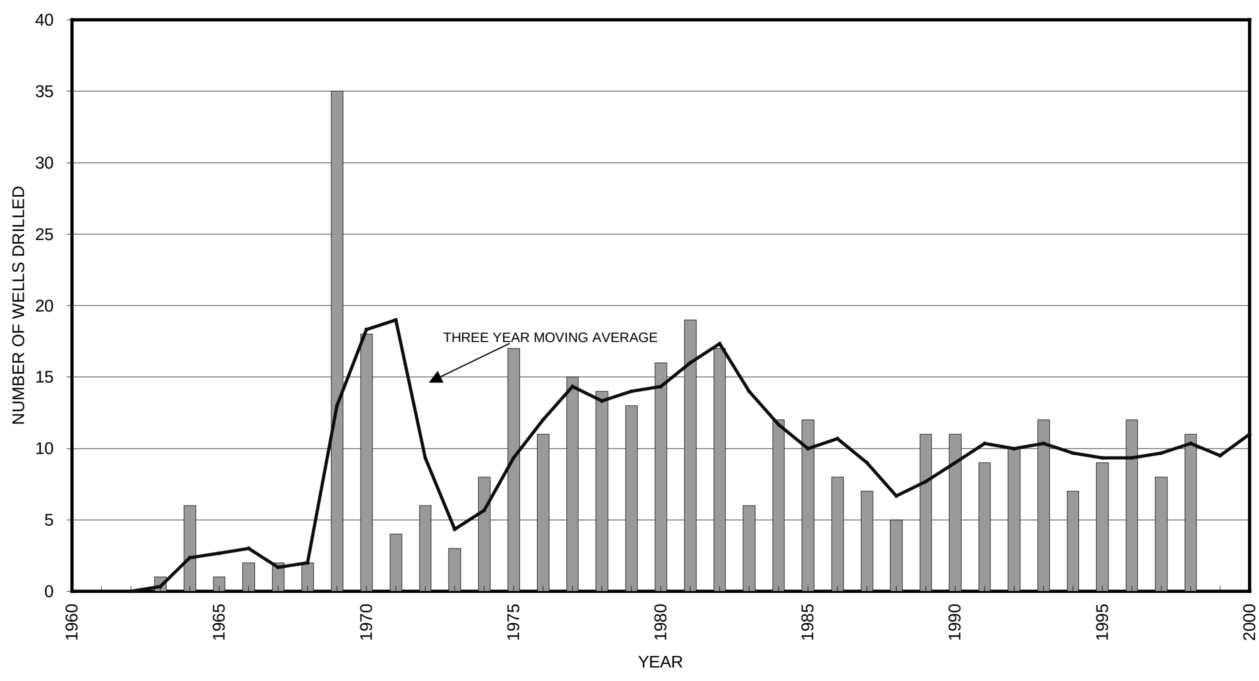
This section begins by summarizing the leasing and exploration that has occurred to date, and the production history for North Slope/Beaufort Sea fields. The section continues with a discussion of the effects of post-sale activities on fish and wildlife, communities, historic and cultural resources, subsistence, and air and water quality. A discussion of the fiscal effects of the sale is also included.

1. Exploration and Production

Oil seeps have long been known to the Eskimos of the North Slope. According to archaeological evidence, oil shale was used for fuel by early Eskimos. Early traders reported seeps along the coast. The first geologic and topographic studies date back to 1901, and the first formal descriptions were recorded by the U.S. Geological Survey in 1919. Onshore exploration continued with drilling and seismic surveys beginning in the 1940s, yet offshore exploration did not begin until technology was developed in the mid-1970s. The first offshore well was drilled on a gravel island (Reindeer Island) in 1979 near Prudhoe Bay.

Of the 401 exploration wells drilled on state acreage in the North Slope and Beaufort Sea as of year-end 1997, 53 discoveries have been made for a success ratio of 13.2 percent. There have been 31 exploration wells in the federal waters of the Beaufort Sea, resulting in five discoveries: Seal Island/Northstar, Kuvlum, Hammerhead, Sandpiper, and Tern Island/Liberty. Figure 5.3 shows the number of exploration wells drilled each year since 1960.

Figure 5.3 Alaska Exploration Well Data, North Slope Wells



To date, over 30,000 miles of conventional (2-D) seismic surveys have been conducted on state acreage on the North Slope and in the Beaufort Sea. In addition, over 5,200 sq. mi. of 3-D seismic surveys have been permitted in this region since 1985.

Table 5.2 lists the known oil and gas accumulations on state lands onshore and in state and federal waters, and Figure 2.3 shows their locations. Five of the producing fields are offshore (Badami, Endicott, Milne Point, Niakuk and Point McIntyre). However, all except Endicott and Point McIntyre are being produced directionally from onshore facilities. Both Endicott and Point McIntyre utilize causeways (Endicott also utilizes two artificial islands) to support offshore drilling and production facilities. In addition, BPX has announced plans to produce the Northstar Field totally from offshore facilities (PNA, 1996).

Table 5.2 North Slope and Beaufort Sea Oil and Gas Accumulations

	Est. Ultimate Recovery		Percent Depleted	
Accumulation	**Oil (MMBO)**	**Gas (Tcf)**	**Oil**	**Gas**
Producing				
Badami	120	100		1%
Duck Island Unit				
Eider				
Endicott	600	979	63%	13%
Sag Delta North	8			
Greater Point McIntyre				
Lisburne	160	347	74%	-11%
Niakuk	75	30	30%	52%
N. Prudhoe Bay State(shut-in)	3.2		23%	
Point McIntyre	408		43%	16%
West Beach	1.9			
Kuparuk River Unit				
Kuparuk	2,681	970	60%	38%
Tabasco				
Tarn	42			15%
West Sak	300		0%	
Milne Point Unit				
Milne Point	115	9	33%	50%
Sag River			5%	
Schrader Bluff	400		3%	
Prudhoe Bay				
Midnight Sun				
Prudhoe Bay	13,218	26,687		11%
Undeveloped/Under development				
Alpine	365			
Liberty	120			
North Star	375			
Pt. Thompson	200			
Fiord	50			

Source: Beasley, 1999

Fields proposed for development, but not yet producing include Northstar, Alpine, and Liberty. Northstar, located about six miles northwest of Prudhoe Bay, is estimated to contain 375 million barrels of economically recoverable oil. The development has received the necessary permits and BPXA plans to begin island and pipeline construction in 2000, with production scheduled to begin in late 2001 (MMS, 1999). In October of 1996, ARCO Alaska, Anadarko Petroleum Corporation, and Union Texas Petroleum Alaska Corporation, announced plans to develop the Alpine field in the Colville River area west of the Kuparuk oilfield. The field has an estimated 365 million barrels of economically recoverable oil, and production is anticipated to begin by the year 2000 (PNA, 1997). The Liberty field is located on federal leases approximately five miles offshore in the Beaufort Sea, northwest of the Badami field. BPX owns the lease and estimates there are 120 million barrels of recoverable oil. Production probably will begin in 2003 (ADN, 1997a).

Another potential development includes Sourdough. In 1997, BPX and Chevron announced the discovery of the Sourdough field next to ANWR. Current information indicates Sourdough could contain 100 million barrels of recoverable oil. Further exploration is needed before determining whether to develop the field. The Sourdough project would require up to 35 miles of pipeline to link up with the Badami field to the west (Peninsula Clarion, 1997).

As production of existing fields continues, production and development well drilling, and well workovers will occur into the future. The extent of activity is likely to decline as fields become depleted. Several undeveloped accumulations (e.g. Sourdough) are located beyond the existing pipeline infrastructure. These accumulations may or may not be developed. Existing fields also contain considerable amounts of gas that may be extracted and transported to market in the future. Tapping the North Slope's gas reserves may require additional facilities, wells, and a new pipeline.

It is reasonable to assume that some exploration drilling will occur on tracts leased in this sale within the initial term of the lease. However, whether or not exploration and eventual development will occur in areas of the Beaufort Sea depends on several factors, since the cost of transporting the oil to market is much greater: 1) the subsurface geology of the area, 2) a company's worldwide exploration strategy, and 3) the projected price of oil and the demand for it. Geology dictates the extent of exploration. Several dry holes (no substantial hydrocarbons encountered) can discourage further exploration in an area. Whether a lessee proceeds with exploration of an area may depend on the area's priority when weighed against the lessee's other worldwide commitments. If extensive exploration does occur in an area, and an accumulation is discovered, development and production will only proceed if the lessee can be assured an acceptable profit. This depends on the price of oil, the lessee's development costs, and the cost of getting the oil to market.

Since 1964, over 4.6 million acres of state land have been leased in 28 state oil and gas lease sales in the North Slope and Beaufort Sea. Some of this acreage has been leased more than once because some leases had previously expired or were relinquished. As of May 3, 1999, just over 2.4 million acres of state acreage were under lease onshore and offshore (Table 5.3). Of that, about 22 percent of the acreage was completely offshore. Just less than 18 percent of the active leases in the region straddle the coast (ADNR, 1999). Regardless of the acreage offered in a sale, or held under lease, the amount of land that will eventually experience oil and gas activity gets smaller with each succeeding phase. Historically, only about half of the tracts (51.6 percent) offered in state oil and gas lease sales have been leased. Of the leased tracts, slightly more than 10 percent have actually been drilled on, and about 5 percent of the leased tracts have been commercially developed.

Table 5.3 Current Lease Activity North Slope and Beaufort Sea

Lease Sale Areas	Number of Leases	On-Shore Acreage	Off-Shore Acreage	Total Acreage
Onshore	579	1,749,653.85	0	1,749,653.85
Coastal	159	145,641.96	310,067.19	455,709.15
Offshore	165	0	221,302.62	221,302.62
Active Leases	903	1,895,295.81	531,369.81	2,426,665.62

Source: DO&G, 5/7/99

2. Effects on Lower Trophic-Level Organisms

Organisms near the bottom of the food chain include marine plankton, shellfish, marine invertebrates, and terrestrial vegetation. Some oil and gas activities may affect the viability, distribution, reproduction, and abundance of these creatures, which may in turn affect animals that feed on them. Habitat protection measures are designed to minimize adverse effects from potentially harmful oil and gas activities.

a. Seismic surveys

Seismic surveys are expected to have little or no effect on plankton, because the energy sources (airguns) do not appear to have any adverse effect on this group of organisms. In general, even high explosives have had relatively little effect on marine invertebrates. Airguns also were shown to have no lethal effect on caged oysters placed close to the airguns. Seismic activities are, therefore, expected to have little or no effect on lower trophic level organisms (MMS, 1998:IV-B-7)

b. Drilling and Production Discharges

The types of materials discharged while drilling include drilling muds and cuttings. During production, the main discharge is produced waters. These discharges contain small amounts of hydrocarbons and create plumes of material that disperse rapidly in the water column. In most continental shelf areas, most drilling muds and cuttings land on the sea bottom within 1,000 m the of the discharge point. The effect of drilling discharges on lower trophic-level organisms appears to be restricted to benthic organisms living nearest to the discharge source. There is no evidence of effects on plankton from drilling muds (MMS, 1998:IV-B-7).

Discharge of produced waters into open or ice covered waters less than 33 ft. is prohibited and nearly all of the sale area is in waters that are 33 ft. or less. For those areas deeper than 33 ft., the commissioner of ADEC may approve discharges on a case-by case basis. MMS estimates that drilling discharges would affect less than one percent of benthic organisms and none of the plankton. Affects would mostly be sublethal but some benthic organisms would be killed (MMS, 1996: IV-H-4).

During exploratory well drilling, muds and cuttings are typically discharged onto sea ice. This silty material, similar to riverine overflow sediments, may block sunlight and reduce photosynthesis of plankton in the water column, however, the area of impact would be limited to the immediate vicinity of the drill site. These cuttings are carried out to sea with the drifting pack ice after spring break-up.

Based on studies results, benthic organisms within 1,000 m of a platform are expected to experience mostly sublethal effects, with some lethal effects on immature stages. Within this distance, some changes are expected in the species composition of affected benthic areas. Recovery of the affected benthic communities is expected to occur within one year after drilling discharges cease (MMS, 1998:IV-B-7).

c. Effects of Construction

Offshore construction typically involves the placement of bottom-founded production platforms and pipeline laying. These activities normally would affect only benthic invertebrates and marine plants in the immediate vicinity. Construction is expected to have little or no effect on phytoplankton or zooplankton communities. However, dredging can affect benthic invertebrates and marine plants by physically altering the benthic environment, increasing sediments suspended in the water column, and killing organisms directly through mechanical actions. Platform placement and pipeline laying is expected to kill the less mobile benthic organisms in their path. The more mobile organisms are expected to avoid these areas of disturbance and not be affected. On the beneficial side, platforms provide additional habitat for those marine invertebrates and plants that require a hard, secure substrate for settlement. The overall effect of a platform would be to alter species diversity near the platform in favor of organisms requiring hard substrates over those that do not. Construction is expected to have little adverse effect on lower trophic-level communities. The mobile benthic communities affected by pipeline construction are expected to recover in less than three years (MMS, 1998:IV-B-7).

Population level (Beaufort wide) effects from construction of production islands and pipelines, and from caisson use on lower trophic-level communities is very unlikely, because of the relatively small area affected. (MMS, 1996, IV-H-4). Construction of gravel islands has had a short-term (1 to 2 years) affect on some benthic organisms in areas near islands or dredging sites (MMS, 1996, IV-H-8). Recovery time assumes that populations are stable or increasing at the time of impact. For those populations that may be declining, recovery to pre-development conditions may take longer. Populations may not recover if there is a continuous toxic discharge from the project site or facility, which exceeds effluent discharge limits set by EPA.

d. Gravel Islands

Gravel islands may be constructed in the nearshore zone off river deltas in areas of high deposition. During high flow periods, the Colville River and Sagavanirktok River delta systems transport and deposit large volumes of sediment in the nearshore environment. The sedimentation and turbidity caused by gravel island construction would be nearly undetectable against the natural process of sediment loading in the Colville River delta system (NTS, 1981:13). The greatest effects on water turbidity that construction may have would be during clear water phases, which occurs during frozen conditions.

Increased turbidity can effect biological productivity by preventing sun light from penetrating the water column. During the winter, ice, temperature, and lack of sunlight are more influential in affecting biological productivity than water turbidity.

During construction of gravel islands, benthic creatures are effected by burial and by the down current sediment plume. A study for Sagavanirktok Delta pad No. 7 & 8, found the sedimentation volumes during gravel island construction were 10 cm. at 40 m to 80 m from the island and less than one cm at 240 m from the island (NTS, 1981). Factors affecting sedimentation are current speed, construction materials and depth of water. It was concluded that at distances beyond 100 m from the island, it would be difficult to detect differences in sedimentation volume between gravel island construction and natural sedimentation in the area.

e. Ice roads and Pads

Ice roads and pads cause depressions in microtopography due to compaction. The thaw depth in summer increases beneath the impacted area after melt and there is an increase in wetness due to compression. Ice roads compress and shear tussocks, which may take up to four years or more to recover (Noel and Pollard, 1996, citing to Walker, et al., 1987). Ice road and pads also affect tundra regeneration, with certain species recovering faster after summer melt than others. Vegetation should recover within three seasons following melt. Ice road thaw depths return to pre-impact levels after several years (Noel and Pollard, 1996).

f. Effects of Natural Gas Development

If a natural gas blowout occurred, some marine invertebrates in the immediate vicinity might be killed. Natural gas and condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. A plume of natural gas vapors and condensates would be dispersed very rapidly from the blowout site, but is not expected to be hazardous for greater than one kilometer downwind or for greater than one day. Activities associated with laying a gas pipeline would have localized effects on marine organisms. Mobile organisms such as adult crabs, are expected to have virtually no adverse effects; however, longer-term but extremely localized effects over a small area are possible for immobile benthic organisms, such as clams. In some instances, the alteration of the benthos by pipeline laying could enhance habitat for some lower trophic level organisms. Natural gas exploration and/or development in the Beaufort Sea are expected to have little to no effect on lower trophic-level organisms (MMS, 1998:IV-III-9).

g. Oil Spills

The effects of oil on phytoplankton, zooplankton, and benthic communities range from lethal to sublethal. Adverse effects are expected to be greater in areas where water circulation is reduced, such as bays and estuaries. Phytoplankton would regenerate rapidly (9 to 12 hours) limiting any effect on phytoplankton communities, which may affect animals at higher trophic levels. Zooplankton communities experience short-lived effects from oil and appear to recover rapidly due to their wide distribution, large numbers, and rapid rate of regeneration (MMS, 1996, IV-H-4). If oil entered the substrate, some specie communities may require years to recover, and may be completely replaced by more hydrocarbon-tolerant specie communities.

Some hydrocarbons are naturally produced by phytoplanktons, and many have been found to be the same as, or similar to those found in crude oil. Some hydrocarbons, therefore, are considered a normal part of the chemical makeup of phytoplankton. Hydrocarbons occurring in the water column that are similar to those occurring naturally in phytoplankton are expected to have little effect on these organisms. Other petroleum-based hydrocarbons (e.g. chlorinated hydrocarbons) are not of natural origin and may have adverse effects on some phytoplanktons, even at low concentrations (MMS, 1998:IV-B-8).

Effects on phytoplankton vary widely, depending on the concentration and type of oil or compounds used in experiments on the species being tested. Nevertheless, general patterns do exist, and both laboratory and field studies have shown that hydrocarbons typically inhibit phytoplankton growth at higher concentrations, but sometimes enhance growth at lower concentrations (MMS, 1998:IV and-B-8).

In cases where studies have been conducted following an oil spill, this lack of substantial adverse effects on phytoplankton populations from spilled oil is common. Even if it is assumed that large numbers of phytoplankton are contacted by an oil spill in an open-ocean area, the regeneration time of the cells (9-12 hours) and the rapid replacement of cells from adjacent waters are expected to preclude any major effect on phytoplankton communities. Further, vertical distribution of most phytoplankton in the water column typically is below the area were they would be adversely affected by hydrocarbons associated with oil spill. For these reasons, a large oil spill is not expected to have significant effects on phytoplankton. Recovery from the effects of a large oil spill is expected to take only one to two days (MMS, 1998:IV-B-8).

Effects of petroleum-based hydrocarbons on zooplankton have been observed in the field at spill sites and also in the laboratory. It should be noted that some zooplankton have the ability to metabolize some types of hydrocarbons, and that ability varies between species. The observed vulnerability of zooplankton to hydrocarbons (dispersed and dissolved) in the water column varies widely. Lethal hydrocarbon concentrations for zooplankton range from about 0.05 to 10 ppm, which is similar to that expected for other small floating organisms (e.g., fish larvae and crustacean). Sublethal crude-oil concentrations for zooplankton range from about one ppm to well below 0.05 ppm. Sublethal effects include lowered feeding and reproductive activity, altered metabolic rates, and community changes. The effects depend on exposure time, hydrocarbon toxicity, species, and life stage involved (early stages are most sensitive)(MMS, 1998:IV-B-8).

Field observations of zooplankton communities at oil spills and in chronically polluted areas have shown that the communities were affected, but these effects appear to be short-lived. Individuals within chronically polluted areas have experienced direct mortality, external contamination by oil, tissue contamination by aromatic constituents, inhibition of feeding, and altered metabolic rates. However, because of their wide distribution, large numbers, rapid rate of regeneration, and high fecundity, zooplankton communities exposed to oil spills or chronic discharges in open water appear to recover. In areas where flushing rates and water circulation are reduced, the effects of the oil spill are expected to be greater, and recovery of zooplankton biomass and standing stocks are expected to take somewhat longer (MMS, 1998:IV-B-8).

Benthic communities are higher in marine food chain than plankton, with some forms feeding on plankton and others feeding at higher trophic levels. Many benthic species are fed upon by higher food chain species, such as marine fishes, birds, and mammals. Benthic flora, such as those found in the Boulder Patch in Stefansson Sound, also provide shelter for small fish and invertebrates and decreases erosion and turbidity. Any significant effect on benthic-level organisms (natural or unnatural) would be expected to have an effect on higher trophic levels as well (MMS, 1998:IV-B-9).

In the marine environment, hydrocarbons resulting from an oil spill are broken up by wave action into three phases: floating surface oil; dispersed and dissolved oil within the water column; and oil that is incorporated into bottom sediments. Marine plants and animals are affected most by floating surface oil and oil that is being incorporated into the bottom sediments through wave action. In marine environments that have distinct intertidal and subtidal flora and faunal communities, the most persistent effects often occur when intertidal and shallow subtidal benthic communities are contacted by oil, particularly in areas where water circulation is restricted (e.g., bays, estuaries, mud flats, and rock armored shorelines) (MMS, 1998:IV-B-10).

In the Beaufort Sea there is no intertidal zone in the traditional sense. This is due to the annual pre-dominance of shore fast ice, which precludes marine plant life and most fauna along the shoreline. Nonetheless, marine plants do exist subtidally at a few locations in the Beaufort Sea, such as the Boulder Patch community. The estimated effect of a large oil spill on subtidal marine plants in the Beaufort Sea area depends on the type and amount of oil reaching them. However, the only type of oil that can reach marine plants in the subtidal zone (most are 5 to 10 m deep) would be highly dispersed oil having no measurable toxicity due to heavy wave action and vertical mixing. The amount and toxicity of oil reaching subtidal marine plants is expected to be so low as to have no measurable effect on them (MMS, 1998:IV-B-10).

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Discharge of produced waters in marine waters less than 33 ft. deep is prohibited. Offshore discharge of produced waters must meet EPA effluent discharge standards.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate cleanup.

3. Effects on Fish and Wildlife Habitats, Populations, and Uses

a. Fish

Habitat loss or alteration. Placement of causeways, particularly continuous-fill causeways into the nearshore Beaufort Sea or in river deltas can alter patterns of nearshore sediment transport, alter patterns of water discharge to the nearshore environment, and alter temperature and salinity regimes in areas near the causeway. The extent of alterations depends on the size or length of the causeway, its location relative to nearby islands and river mouths or deltas, and pre-causeway oceanographic characteristics. Minimizing alterations is accomplished by proper siting, minimal size, and by ensuring that breaches are sized and located to maximize goals. Changes to the physical environment may alter patterns of use of the deltaic area by anadromous and marine fishes. Changing marine current flow and circulation patterns result in physical changes to delta channeling and shorelines which could affect use by animals that feed on fish, such as shorebirds and waterfowl (Winters, 1996).

In the case of the West Dock causeway, the structure diverts the nearshore current along the coast, resulting in colder, more saline water entering a lagoon that had been warmer and less saline before construction. Studies revealed that the oceanographic characteristics of this pass area (and lagoons) were important to fish migration. Fish catch data revealed that saltwater-intolerant fish utilize the warmer less saline nearshore zone as they migrate from the Mackenzie River system in Canada. Anadromous fish may also travel from other river deltas, such as the Colville to feed, utilizing the lagoons shoreward of the barrier islands.

East wind-induced eddies at West Dock creates a cell of cold, saline water in the normally warm and brackish nearshore zone, which may occasionally disrupt the eastward movement of Colville River young least cisco during their summer nearshore feeding migration. But this infrequent occurrence has had no apparent affect on least cisco populations (Fechhelm et al. 1994).

After West Dock was constructed and extended (after a barge became stuck in the ice), there was concern that the structure restricted the ability of fish to avoid cold saline water during their migration. Small Arctic cisco are transported to the Prudhoe Bay area when northeast winds are sufficiently strong and long-lasting to induce longshore movement of water from the Mackenzie River in Canada (Gallaway et al. 1991).

The cell of colder saline water between Stump Island and the causeway, created by eddying off the tip of the structure, occurs at a key point along the migratory path. These conditions may block eastward movement around the causeway, specifically for smaller fish. Fish whose migration may be disrupted include least cisco, small Arctic cisco, and large broad whitefish. Dolly varden char are stronger swimmers and more tolerant of saline water, and studies indicate that their movements have not been impacted by either causeway (Gallaway et al., 1991; Colonell & Gallaway, 1990).

Similar concerns were raised about the Endicott causeway. After extensive studies and debate, a negotiated settlement agreement was reached between the Army Corps of Engineers and industry to breach the two causeways, thereby providing fish access to the lagoonal migratory corridor, and bring both structures in compliance with state water quality standards (USACE, 1991).

Due to the variability in oceanographic characteristics from year to year, a multi-year monitoring program would be necessary to accurately determine pre versus post-construction effects. A multi-year pre-construction baseline sampling program plus a multi-year post-construction program are necessary to document any adverse effects on fish (Winters, 1996).

Despite extensive research into their effects, evidence that the two causeways have had significant population level impacts on anadromous fish remains inconclusive. Some analysists are convinced that impacts of causeways significantly affect fish abundance, and attribute population declines in rivers to Endicott or West Dock, while others are not. Fish abundance and presence in the region in a given year may be influenced by larger forces, such as mesoscale wind phenomena and recruitment success in natal streams. Regardless of the conclusiveness about effects of the Endicott and West Dock causeways, individual fish throughout repeated migrations in their life cycle are likely to be stressed by a solid fill causeway extending into the Beaufort Sea at key locations near barrier islands. Any gravel structure which obstructs the natural migratory corridor near river mouths has the potential to adversely affect anadromous fish. Altering temperature and salinity in nearshore waters may affect the distribution and abundance of organisms upon which fish feed. For these reasons, solid or continuous fill causeways are discouraged, and many designs, although ideal for field development, are unsuitable for the nearshore environment. Additionally, significant alterations of the shoreline or changes to natural temperature and salinity patterns are prohibited.

The environmental effects of any causeway would be, in part, determined by its proximity to major tributaries and the shape of the coastline, and those effects could be minimized by proper siting and construction. Although the early phases of West Dock and Endicott were constructed without breaches, it is highly unlikely that a continuous fill causeway designed like those would be permitted in the nearshore Beaufort Sea. Some causeway designs could enhance marine productivity and facilitate propagation of fish species. Several years of oceanographic studies and fish sampling have been conducted in Mikkelsen Bay, where a causeway or dock has been planned for the Badami Development Project. No other causeway-type gravel structures are planned for developing nearshore Beaufort reserves.

The environmental effects of gravel islands are small relative to causeways and, following their construction, are not likely to significantly alter water quality parameters or fish migration. Artificial gravel islands may be sited in the warm brackish zone in the near shore area which is used as a feeding and migration area for the fish of the Colville, Sagavanirktok, and other river systems. Considering the natural construction materials used and that the coastal geomorphology of the area is quite dynamic, a gravel island would have little long-term effects on fish populations. Observations of the abandoned Milne Pt. gravel island, indicate no adverse effects on the surrounding environment. The island has eroded and is currently under water.

Gravel islands have not had a long term or significant affect on the surrounding ecosystem, and it is unlikely that they would interfere with migrating marine mammals or anadromous fish. The primary concern is not the island itself, but potential oil spills, especially at critical times and locations.

It is likely that some oil transport to onshore facilities would be accomplished by undersea pipelines, such as those currently being developed for BPX's Northstar site. The pipelines will be installed by digging trenches in the sea floor, which will create additional sedimentation. Fish and epibenthic invertebrates annually recolonize shallow habitat that is seasonally disturbed.

The cumulative effects on fishes from the installation of pipelines in the undersea trenches should be localized and temporary, unless if it occurs during the time of fish migration. At that time, the construction would disrupt the fishes migration patterns. However, it is likely that cumulative adverse effects to fishes could result from the excess dirt from the trenching activities being temporarily stored on the ice surface. This dirt could be up to one foot deep on the ice surface and have an insulation effect on the underlying ice, causing a significant lag in the area's natural processes and interfere with the important summer, nearshore coastal band of water. This would adversely affect fish migration and feeding in the area. Specific adverse effects to fishes from the under sea pipeline process have yet to be determined (MMS, 1998:IV-G-7).

Oil spills. The shallow nearshore zone of the Beaufort Sea is used extensively by anadromous fish for feeding. If a very large oil spill occurred in marine waters during the open season it may affect the ability of fish to reach overwintering areas and spawning streams. Adult fish are likely to avoid an oil spill and not suffer great mortality; but larvae, eggs, and juveniles are more vulnerable because they are more sensitive and less mobile, and are more likely to be adversely affected. Species with floating eggs, such as Arctic cod, could suffer extensive mortality depending on the extent and amount of oil spilled (MMS, 1996: IV-B-17). The total number of fish killed depends on the volume of oil discharged, the time of year of the spill, and the prevention, response and preparedness of clean-up efforts.

The effects of an oil spill on fishes could vary, depending on where it occurred and what areas were affected. Adverse effects from a spill could include skin contact, respiratory distress from gill fouling, localized reduction in food resources, consumption of contaminated prey, displacement from migratory routes, and temporary displacement from local habitat. Nearshore habitats, especially those in the delta areas, are of critical importance as overwintering habitat for several anadromous and amphidromous fishes during the winter season. In the summer season, a nearshore band forms along the Beaufort Sea coastline when coastal river freshwater combines with shallow marine water decreasing marine salinity and elevating water temperatures. This band provides a major feeding area for fishes during the summer season. Disruption as a result of an oil spill could have significant adverse effects to several fish species using these habitats during these seasons (MMS, 1998:IV-G-8). These effects could be non-lethal or lethal, depending on the circumstances (MMS, 1998:IV-G-9).

Seismic activities. Airguns are used to gather subsurface data beneath the sea during the exploration phase. This release of acoustic energy can disturb and displace fishes and interrupt feeding in the immediate vicinity of the activity. High pressure impulses could injure fish with air bladders, but the impulses would dissipate to a non-lethal level within a short distance (less than 100 m) (MMS, 1996: IV-B-16). Marine fishes are likely to incur minimal effects from seismic surveys due to their ability to move and avoid the affected area. A study conducted in the early 1990's assessed the physics and mechanics of seismic survey methods on fish of the Norweigan Continental Shelf and concluded that modern geophysical exploration methods appear to have little direct impact on marine life (Gausland, 1992). The use of explosives in marine waters is prohibited.

Virtually all onshore seismic is conducted using truck-mounted vibrators. Pressure waves from high explosives, like ammonia nitrate will kill and injure fish, near the explosion (Fink, 1996 citing to Trasky, 1976; Falk and Lawrence, 1973; Hill, 1978). Overpressures 30 to 40 psi will kill fish with swim bladders, and 3 to 4 psi will kill juvenile salmonids. Shock waves from explosions can also shock and jar fish eggs at sensitive stages of development (Fink, 1996, citing to Trasky, 1976; Linton et al., 1985). These types of impacts are mitigated by restricting the use of explosives in open water or in close proximity to fish-bearing lakes and streams. Other restrictions include requiring that seismic activities be far enough away from freshwater spawning areas where shock waves are reduced to safe levels before reaching incubating eggs during sensitive stages of development (Fink, 1996).

Seismic surveys would also be conducted in shallow nearshore areas and within river deltas during the winter. Noise effects on fishes could include local avoidance of seismic surveys, aircraft and vessel traffic, drilling and construction activities, and production operations. However, the fishes' ability to avoid noise in disturbances would be significantly curtailed if the noises occurred in nearshore brackish and freshwater areas during winter season when fish are restricted in their critical overwintering habitat. The significant increase in the disturbance levels could cause a variation in some fishes migration patterns. This alteration could adversely affect the fishes' recruitment and survival. However, no scientific evidence is available to indicate if industrial noise and disturbance in an area for a number of years would adversely affect fishes and those areas (MMS, 1998:IV-G-9). Fishes likely would avoid these activities, if possible (MMS, 1998: IV-G-7).

Marine Discharges. Marine disposal of drilling muds, cuttings, and produced waters may have potential toxic effects to organisms. Water quality tests however, indicate that lethal concentrations are generally present only within a few meters of the discharge point (MMS, 1984: IV B-4 and B-5). The effect on fish depends on the dilution of the discharge. In shallow depths with poor circulation, the effect is a reduction on benthic populations. Little effect was noted in depths of 66 ft. or shallower with dissipating tidal or current action (MMS, 1984:IV-B-5).

Drilling and production discharges could displace fishes a short distance from the source however, the effects would be localized and temporary, and low-level. It is expected that the fish would re-utilize their habitat upon completion of the activities (MMS, 1996: IV-H-5).

Discharges in shallow, ice-covered waters are presently restricted. Therefore, the likelihood that fishes would be exposed to discharges during their critical overwintering period for relatively long periods of time in areas of little circulation is reduced. Effects to fishes from drilling and discharges likely would be local and temporary (MMS, 1998: IV-G-7).

Effects of Natural Gas Development. If a natural gas blowout occurs, fishes, eggs, and larvae near the blowout point might be killed or temporarily stunned from the abrupt increase of pressure in the immediate aquatic area. However, significant fish deaths are not likely to occur due to the wide distribution and low density of fishes in the sale area (MMS, 1998:IV-HL-10). Natural gas condensates in the water column would be hazardous to any fish, eggs, or larvae that were exposed to high concentrations. However, a plume of natural gas vapors and condensates would disperse rapidly from the blowout site. Some gas may be trapped beneath the ice temporarily, but impacts to fish are likely to be minimal (MMS, 1996: IV-L-2).

Activities associated with laying an under sea gas pipeline would have localized and temporary effects on fishes. Disturbance of the benthos during drilling in pipeline laying probably would displace fishes a short distance, but they would likely recolonize this naturally, seasonally disturbed habitat. However, adverse effects on fishes could result if excess dirt from the under sea pipeline construction is temporarily stored on the ice surface. The deposited dirt could have an insulation effect on the underlying ice causing a significant lag in the area's natural processes and interfere with the important summer, nearshore coastal band of water. This could adversely affect fish migration and/or feeding in the area. Fishes in critical and scarce nearshore overwintering habitat, especially in river and delta areas, could be particularly vulnerable due to their dependency on these areas and their inability to move (MMS, 1998:IV-HL-10).

Mitigation Measures

Title 16 of the Alaska Statutes requires protection of documented anadromous streams from disturbances associated with development. The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Habitat Protection -- Lessees may be required to construct ice and/or snow bridges if ice thickness at a crossing is insufficient to protect the streambed and the stream bank. Any removal of water from fishbearing streams, rivers, and natural lakes requires written approval. When a fishbearing waterbody is used as a water source, lessees must use appropriate measures to avoid entrainment of fish (prevent fish from being drawn into the intake pipe). Lessees must locate, develop, and rehabilitate gravel mine sites in accordance with ADF&G guidelines. All discharges into upland waterbodies must meet state water quality standards. Disposal of produced waters in upland areas is prohibited. Disposal of wastewater, such as domestic greywater, into fresh waterbodies is prohibited.

- Marine Discharge -- Discharge of produced waters into open or ice covered waters less than 33 ft. is prohibited. Discharge of muds and cuttings is prohibited shoreward of the 5-meter isobath. Nearly all of the sale area is in waters that are 33 ft. or less. For those areas that are greater than 33 ft., the commissioner of ADEC may approve discharges on a case-by case basis. Under the NPDES general permit, discharge is not authorized within 1,000 m of Steffansson Sound. Discharge is prohibited within 1,000 m of river mouths or deltas during unstable or broken ice or open water conditions.

- Stream Buffers -- Onshore facilities other than roads, docks, and airstrips must not be sited within 500 ft. of all fishbearing streams. Facilities may not be sited within 1/2-mile of the Colville, Canning and Sagavanirktok, Kavik, Shaviovik, Kadleroshilik, Echooka, Ivishak, Kuparuk, Toolik, Anaktuvuk and Chandler Rivers. No facility will be sited within 100 ft. of any fishbearing waterbody. Road and pipeline crossings must be perpendicular to watercourses to prevent buffer erosion.

- Obstructions to Migration and Movement - Continuous-fill causeways are discouraged. Any proposed causeway must be designed, sited, and constructed so as to maintain free passage of marine and anadromous fish, and shall not cause significant changes to nearshore oceanographic circulation patterns and water quality characteristics that result in violations of state water quality standards. Causeways may not be located in river mouths or deltas. Monitoring programs and mitigation, such as breaching, may be required to achieve intended protection objectives.

- Activities that may block fish passage in anadromous streams are prohibited. Alteration of river banks, except for approved crossings is prohibited. Operation of equipment other than boats in open water areas of rivers and streams is prohibited. If bridges are not feasible, culverts used for stream crossings must be designed, installed, and maintained to provide efficient passage for fish.

- Protection from Seismic Activities -- Lessees must follow requirements for the use of explosives during onshore seismic activities. Use of explosives in open water areas during offshore seismic activities is prohibited.

- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, preparedness, response capability, and cleanup of oil spills. Lining and diking of oil or fuel storage tanks is mandatory, and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

b. Birds

As described in Chapter Three, the Arctic Coastal Plain's abundant wetlands attract large numbers of important migratory waterbirds each year. Some nesting, molting, and staging bird species are sensitive to activities associated with development. Generally, responses to industrial activities depend on species exposed, the physiological or reproductive state of the birds; distance from the disturbance; type, intensity, and duration of the disturbance; and possibly other factors (MMS,1996: IV-B-21). Potential impacts are more likely to occur after the exploration phase, as few resident species are present during winter when exploration occurs. Potential impacts include: habitat loss, barrier to movement, disturbance during nesting and brooding, change in food abundance and availability, and oil spills.

Drilling and Production Discharges. Discharged materials typically disperse rapidly in the water column, and deposition occurs near drill sites. Because most post-breeding waterfowl exist in widely dispersed flocks, relatively few are expected to inhabit local drillsites or feed on prey from drillsite areas. Thus, discharges are not expected to cause significant effects either through direct contact with the birds or by affecting prey availability (MMS, 1998:IV-B-41).

Habitat loss. Siting of onshore facilities such as, roads, airfields, pipelines, housing, oil storage facilities, and other infrastructure could eliminate or alter some preferred bird habitats such as wetlands. Onshore pipeline corridors may include a road and associated impacts from traffic, noise and dust may deter nesting in the immediate vicinity. The construction of offshore pipelines or re-supply activities could have temporary effects on the availability of food sources of some birds within a mile or two of the construction area due to turbidity and removal of prey organisms along the pipeline route. Impacts to waterfowl and shorebird populations are not likely to persist after development phase activities are completed (MMS, 1996: IV-B-23). Barrier islands are key nesting areas and may be unsuitable for some permanent facilities. Birds may however, become habituated to less obtrusive or less threatening island facility designs.

After facilities are built, some birds (individuals) can no longer nest in areas because these areas are covered by the new facility. Additional birds may avoid the areas adjacent to the facility due to disturbance effects. However, it has been observed that these habitat changes have not translated into reduced numbers of birds in the area, as the displaced birds were found nesting in nearby areas and returned at rates similar to unaffected birds. There is no indication that displaced birds settled in habitat inferior to that from which they were displaced because they did not incur disproportionately lower nest success at their new nest sites. Habitat availability is not the resource limiting most bird populations at Prudhoe Bay. Nest predation by Arctic foxes is proposed as the factor most likely limiting population levels (TERA, 1990:35). The USFWS disputes this conclusion, citing the small sample size (only one marked bird lost its nest site, and an additional seven had nest sites that were physically altered in some way). They note, however, the results lend no support to the hypothesis of habitat limitation (Sousa, 1997).

A five-year monitoring program to assess the effects of construction and operation of the Lisburne Oilfield on White-fronted Geese, Brant, Snow Geese, and Tundra Swans was conducted from 1985-1990. The purpose was to determine whether development-related disturbance and habitat loss have caused changes in the extent and nature of use of the Lisburne development area by geese and swans. The study concluded that the Lisburne development did not change the extent or nature of use of the area by geese and swans during construction and the first three years of operation of the oilfield (Murphy and Anderson, 1993:156). This study synthesized the results from pre-construction studies conducted in 1983 and 1984. The pre-construction studies, however, did not investigate all aspects of goose and swan ecology and therefore a complete comparison with pre-development results was not possible (Murphy and Anderson, 1993:1).

Barriers to movement. Black brant populations have experienced periodic nesting failures in the Sagavanirktok and Kuparuk River deltas (Ott 1993). Adults and young are flightless during the brood-rearing period, so roads, causeways, and other related structures may be barriers to brant movements (Sousa, 1992). There is no evidence that the Endicott road/causeway has been an obstruction to black brant movements (Johnson, 1994:11).

An initial concern expressed before construction began was that the Endicott road/causeway would act as a barrier to the movements of brood-rearing flocks of snow geese as they dispersed eastward from Howe Island after hatching in early July. Overall, 14 years of data show no indication that the Endicott development has impeded eastward movements of snow geese from their nesting colony on Howe Island. This result, and the fact that the snow goose population continues to grow at a rate of almost 30 nesting females per year, indicate no significant population level effects of oil development on the Howe Island snow geese (Johnson, 1994a:29-30). However, other studies document abandonment of brood-rearing areas near the Endicott Road, and unsuccessful crossing attempts and failure of crossing the road for periods up to two weeks (Ott, 1997, citing to Envirosphere Co., 1986). Many negative behavioral reactions to the road/pipeline corridor were noted, although no population effect was detected (Sousa, 1997).

The construction of hundreds of miles of roads and pipelines associated with oilfields in the Prudhoe Bay-Kuparuk area has incorporated about 15 percent of prime waterfowl wetland habitat (probably less than or equal to five percent of this has been destroyed), and developing fields could increase this percentage. The loss of bird habitat from any one of the development projects represents a small decrease of the available tundra habitats used by nesting and feeding birds on the Arctic Slope. (MMS, 1998:IV-G-14).

Disturbance. Human activities such as air and foot traffic near nesting waterfowl, shorebirds, and seabirds, could cause some species to temporarily abandon important nesting, feeding and staging areas. Birds have keen eyesight, and even slight movements may cause adults to abandon young hatchlings. A study of effects of aircraft on molting brant in the Teshekpuk Lake area (Derksen et al. 1992) concludes that helicopters (and to a lesser extent, fixed wing aircraft) cause serious disturbance. Some species such as tundra swans, are particularly sensitive to humans on foot, and may abandon their nests when human approach within 500 to 2,000 m of the nest (MMS, 1996: IV-B-21).

Potential sources of disturbance to birds include high levels of air and vessel traffic associated with petroleum exploration. This activity could result in some unrestricted low-elevation flight over concentrations of nesting, feeding, and/or molting birds. Such disturbance is expected to result in short-term displacement of birds from the vicinity of vessels or routinely used air and vessel corridors.

During the height of construction, cumulative aircraft and vehicle disturbance of snow geese, Pacific brant, and other species may cause the birds to avoid certain portions (within about one kilometer of roads and other facilities) of their nesting, feeding, or molting habitats on the Arctic Slope. This could last for one or two generations near roads and other facilities during the nesting season (MMS, 1998:IV-G-14).

However, some research has indicated that some birds may not be readily disturbed. A 1993 study, Bird Use of the Prudhoe Bay oilfield, concluded that on the order of five percent of the birds in the Prudhoe Bay oilfield may have been displaced by gravel placement and secondary alterations of adjacent areas, but that these birds most likely occupy nearby areas. Overall there is rearrangement of birds but probably no net change in bird abundance within the oilfield (TERA, 1993:48). The nesting of most local birds is widely dispersed over the coastal tundra and as a whole, disturbance probably would have little effect on North Slope bird populations (MMS, 1996: IV-B-21).

A study of the Gas Handling Expansion Project (GHX-1) to determine the potential effect of gas-compressor turbine noise on waterbird populations, particularly nesting Canada geese and brood-rearing brant, concluded that noise from the GHX-1 facility made only a small contribution to the total noise around the Central Compressor Plant and the Central Gas Facility and had little effect on the use of the study area by waterbirds (Anderson et al. 1992:110).

In 1985, ARCO Alaska, Inc., initiated a five-year monitoring program to assess the effects of construction and operation of the Lisburne oilfield on Canada Geese, Greater White-fronted Geese, Snow Geese and Tundra Swans. Pre-construction studies were conducted in 1983 and 1984, however they did not investigate all aspects of goose and swan ecology evaluated during construction and post-construction. In addition the Lisburne Field is located within the existing Prudhoe Bay oilfield, where oil development activities have been ongoing since the early 1970s. The study encompassed the construction phase (1985-1986) and the first three years of operation (1987-1989). The final synthesis report concluded that the Lisburne development did not change the extent or nature of use of the development area by geese and swans during construction and the first three years of operation. No major shifts in the use of the study area were detected when comparing survey results between construction and post construction and the limited data on bird distribution from pre-development studies (ABR, 1993:156).

In 1983, Sohio Alaska stockpiled over one million cubic meters of gravel on the western tip of Thetis Island. Operations also involved the installation of a temporary support camp, construction of helicopter landing pad, gravel berms to support two large conveyor belts and a fleet of barges to haul the gravel. Sohio instituted a series of mitigation measures-the establishment of an aircraft flight corridor and buffer zone, a restricted access zone for camp personnel, and, at the request of USF&WS, a program to remove Arctic foxes. The numbers of common eiders nesting on Thetis Island in 1983 were higher than had been recorded in any previous year. The mitigation program implemented by Sohio may have been at least partly responsible for the increase. Three eiders established nests and successfully incubated and hatched eggs at different sites within 300 m of the helicopter landing pad (LGL Associates, 1984:50-54).

Spectacled eiders staging or migrating along the Beaufort Sea coast or nesting in coastal habitats are not expected to experience significant adverse effects from potentially disturbing routine activities (aircraft, vessel, vehicle traffic) during exploration and development/production because the nest sites are scattered and the two migration intervals are relatively brief. Onshore, the sites are scattered at low density over much of the Arctic Slope, and substantial disturbance of nesting are brooding eiders is not expected to occur (MMS, 1998:IV-B-38).

Oil Spills. Direct contact with spilled oil by birds is usually fatal, causing death from hypothermia, shock, or drowning. Oil ingestion from preening oily feathers or consumption of oil-contaminated foods may reduce reproductive ability, and could lead to chronic toxicity through the accumulation of hydrocarbon residues. Oil contamination of eggs by oiled feathers of parent birds significantly reduces egg hatching through toxic effects on chick embryo or abandonment of the nest by parent birds (MMS 1996: IV-B-19). The presence of humans, aircraft, boat and vehicular traffic involved in cleanup activities is expected to cause displacement of nesting, molting, and feeding birds in the oiled areas and contribute to reduced reproductive success of the birds (MMS 1996: IV-B-23). The number of birds impacted by a spill would depend on the time of year and the density of local bird populations. Spill prevention and response are described in Chapter Six, and would apply to any new development in the sale area.

Relatively low spectacled eider mortality is expected from an oil spill unless a spill occurs during the summer or fall periods, when staging/migrating eiders occupy marine habitats. A highly variable proportion of the Arctic Slope population could be vulnerable to an oil spill approaching the Beaufort coastline, primarily west of the Sagavanirktok River. The probability of contact is lowered by individuals being concentrated in relatively few scattered flocks which are primarily onshore during the brief summer fall intervals. However, because such flocks are typically quite large, contact could cause substantial losses. Spectacled eiders are essentially absent from the area from late October to May. If a spill occurred, the presence of substantial numbers of workers, boats, and aircraft flights (depending on spill size) is expected to displace eiders foraging in offshore or nearshore habitats during the open-water periods for one to two seasons. Survival and fitness of individuals may be affected to some extent, but this infrequent disturbance is not expected to result in significant population losses (MMS, 1998:IV-B-38).

Effects of Natural Gas Development. Likely effects associated with natural gas development and production on marine and coastal birds would include some habitat alterations and noise and disturbance from air supported traffic and road traffic along the gas-pipeline route, at the production-platform sites, and at the gas-producing facility site. These effects would be similar to those noise and disturbance and habitat-alteration effects associated with oil development and production (MMS, 1998:IV-HL-11).

If there were a natural gas blowout with an explosion and fire, birds in the immediate vicinity would be killed, which might include several hundred birds. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site; thus it is not likely that fumes would affect birds or their food sources except those very near the source of the blowout. The level of effects on marine and coastal birds resulting from natural gas development and production is expected to be short-term (less than one generation) (MMS, 1998:IV-HL-11).

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Habitat Protection -- Lessees must identify and avoid sensitive habitat areas and site permanent facilities outside of identified brant, white-fronted goose, tundra swan, king eider, and yellow-billed loon nesting and brood rearing areas. Permanent facilities must be sited minimum distances from stream and lakes. Lessees must comply with the USFWS' recommended protection measures for Spectacled eiders during the nesting and brood rearing periods. Lessees are advised to consider identified sensitive bird habitats when planning operations. Permanent, staffed facilities must be sited to the extent feasible and prudent outside identified brant, white-fronted goose, snow goose, tundra swan, king eider, common eider, Steller's eider, spectacled eider, and yellow-billed loon nesting and brood rearing areas.

- Disturbance -- Lessees are advised that aircraft must avoid identified brant, white-fronted goose, tundra swan, king eider, common eider, and yellow-billed loon nesting and brood rearing habitat, and the fall staging areas for geese, tundra swans, and shorebirds, during critical time periods in summer and fall. NSB Municipal Code requires that vehicles, vessels, and aircraft that are likely to cause significant disturbance must avoid areas where sensitive species are concentrated. Horizontal and vertical buffers will be required where appropriate under local code (19.70.050(I)(1)).

- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

If oil development occurs, some alteration of bird habitat can be expected. However, with state and federal government oversight, any activities within the sale area should not prevent overall bird population levels from remaining at or near current levels.

c. Caribou

Although this is primarily an offshore sale, there is a limited amount of onshore acreage. In addition, according to ADF&G, caribou will occasionally stand in water when insects are particularly bad and sometimes have been reported on the barrier islands. The barrier islands are not considered critical or important habitat (Whitten, 1999). Most of the studies and analysis that exist are for onshore caribou impacts. They have been included in this finding to cover the small amount of acreage on which caribou could be found.

Since 1975, both government and industry have conducted research on caribou biology and on various aspects of their interaction with North Slope oil and gas developments. Population characteristics (calf production and survival, and adult mortality), habitat use, movement and distribution, and behavioral responses of caribou to oil and gas development have been studied, but there is disagreement regarding the interpretation of data with respect to its effects. Some researchers attribute declines in caribou populations to oil and gas development, while others think populations (reproduction and viability) are subject to natural cycles in the ability of the land to support large numbers of caribou (carrying capacity). Still others think caribou numbers are influenced by many factors, such as disease, nutrition, predator abundance (including insects), and weather. Hunting pressure and loss of high quality tundra from oil and gas development is not a primary factor in the rise and fall of caribou populations. Nonetheless, studies show that local distribution and behavior of caribou is affected by infrastructure and human activities within producing oilfields.

Potential impacts can occur at all phases, but most are likely to occur during development and production. Potential effects to caribou populations from the sale include displacement from insect relief and calving areas due to construction and operation of onshore and offshore facilities, and from oil spills.

Disturbance. Caribou may be disturbed by onshore and offshore activity. Primary sources of disturbance include vehicle traffic and aircraft. During construction, small groups of caribou may be temporarily displaced, but the disturbance reaction would diminish after construction is complete. If caribou are displaced from calving in a certain area due to construction, they may calve in an area where construction is not taking place. The use of specific calving sites within the broad calving area varies from year to year. If calving caribou are displaced from high nutrition forage near a drill site or facility, they are likely to seek any protective area regardless of the forage. The cumulative effect of displacement from high value tundra could lower calf survival. On the other hand, high populations would force the caribou into lower nutrition areas anyway (MMS, 1996: IV-B-50).

Most calves are born in the uplands (USF&WS, 1987:24). Cow and calf groups are most sensitive to human disturbance just prior to calving, and during the post calving period (Cronin et al., 1994:11). The primary sources of disturbance from oil and gas development are above-ground pipelines which can restrict caribou movement. Ground-vehicle traffic, aircraft, and human presence near cows with newborn calves also affects individuals as they migrate (MMS, 1996: IV-B-50). According to ADF&G, caribou, particularly during calving, may be more affected by oil development than previously thought (Smith and Cameron 1991).

Aerial surveys of radio-collared females conducted between 1978 and 1987 indicate that parturient females can be displaced by road systems (Cameron, et al., 1992). After construction of the Milne Point road, caribou were significantly less numerous within one kilometer of roads and significantly more numerous 5-6 km from roads. In addition to the locally perturbed distribution of caribou, researchers observed a decline in relative use of a portion of the study area between Olitok Point and Milne Point roads. However, the causes of reduced use of oilfield tundra by calving caribou of the CAH is difficult to determine by aerial observations, because of unpredictable random factors, such as weather. "Annual variation in the numbers of caribou observed near Milne Point is primarily an effect of spring snow conditions," (Cameron, et al., 1992:340). Distribution of caribou tends to be skewed inland in years of late snow melt, and concentrated near the coast in years of early melt. In addition to snow conditions and resultant forage availability, relative occurrence of caribou in the Kuparuk River calving area is influenced by predator and insect avoidance behavior. Overall caribou use of an area could be greatly reduced if roads with moderate traffic are routed too closely (Cameron, et al., 1992). In a cumulative sense, the impaired access to portions of their habitat is considered to be a functional loss of habitat (Cameron, et al., 1995).

Caribou can be briefly disturbed by very low-flying aircraft. The response of caribou to potential disturbance is highly variable-from no reaction to violent escape reactions. This depends on their distance from human activity; speed of approaching disturbance source (altitude of aircraft); frequency of disturbance; sex, age and physical condition of the animals; size of caribou group; and season terrain and weather. Habituation to aircraft and vehicle traffic, and other human activities has been reported in several studies of hoofed mammal populations in North America. The variability and instability of Arctic ecosystems dictate that caribou have the ability to adapt behaviorally to some environmental changes (MMS, 1996: IV-B-50).

Disturbance of caribou associated with cumulative oil exploration (particularly by helicopter traffic) is expected to have minor effects on caribou (particularly cow and calf groups) with animals being briefly displaced from feeding and resting areas when aircraft pass nearby. Vehicle traffic associated with transportation corridors (development) has the potential to affect habitat use in intensely developed areas of the Prudhoe Bay-Kuparuk River oilfields. Acute disturbance effects may, in combination, result in a cumulative effect on habitat availability for those individuals with fidelity to the Kuparuk River calving area, but may have little or no effect on the CAH population. Despite the fact that cumulative effects at the population level are difficult to quantify, measures should be incorporated into operations planning and facility design to avoid both direct and indirect impacts to caribou. This may be done at the permitting stage when location and facility specifics are known.

Habitat Loss. It is not expected for there to be much habitat loss as a result of this sale because caribou use of the offshore area is limited. Direct habitat loss would result from construction of pipelines, roads, airfields, processing facilities, housing and other infrastructure. Caribou are subject to mosquito harassment from mid-to-late June through July, and to oestrid fly harassment from mid July to late August. In response, caribou move from inland feeding areas to windswept, vegetation-free coastal areas where the insects are limited. Most mosquito relief areas are found within 4.5 miles of the coast (ADF&G 1986b:67). Caribou use various coastal habitats such as sandbars, spits, river deltas, and some barrier islands for relief from insect pests. (MMS, 1987: III-33). Caribou may use some of the barrier islands and adjacent areas for insect relief. If coastal habitat is unavailable for insect relief, caribou may use foothills south of the Coastal Plain for insect relief (USF&WS, 1987:123). Insect relief zones not only include coastal areas, but mountain tops, river deltas, flood plains, and river bars.

In the absence of available insect-relief habitat, caribou gather into large groups or continue to move into the wind without feeding. A period of extensive insect harassment can result in weight loss. In addition, caribou lose blood (up to 125 grams/day) to mosquitoes and suffer increased parasitism from skin warbles and nasal bot flies. If caribou are delayed or prevented from free access to insect-relief habitat, the result may be deterioration in body condition resulting in decreased growth, increased winter mortality, and lowered herd productivity (USF&WS, 1987:122).

The frequency and duration of caribou movements to and from the coast depend on weather-related changes in the number of mosquitoes, and caribou distribution on the coastal plain can change dramatically within a 24-hour period. Feeding opportunities are limited in windswept insect relief areas, so caribou move inland to better foraging areas whenever insect harassment temporarily subsides, and return to the coast when harassment increases (Shideler, 1986:12). Caribou that remain inland may move to river bars and bluffs to escape insects.

Above-ground pipelines can restrict caribou movement unless provisions are made to allow for their free passage. Biologists representing both industry and ADF&G have agreed that facilities built earlier in the development of the Prudhoe Bay oilfield have created impediments to caribou movements. These pipelines were elevated only 1 to 4 ft. above the surface, thus forming an effective barrier to caribou crossing. However, extensive research on the response of caribou to development has now shown that for many situations it is possible to design facilities so that caribou movements are not significantly impeded. For example, in the Kuparuk River development area, elevating pipelines five feet. and separating pipelines from roads with traffic have allowed caribou to move with ease through the oilfield. Factors influencing the crossing success of caribou beneath elevated pipelines include group size or composition, topography, insect activity, traffic levels, the intensity of local construction, as well as road or pipeline configuration (Shideler 1986). Studies confirm that large numbers of caribou consistently traverse the area during their normal coastward or inland movements in response to insect harassment (Lawhead 1984:8-13).

Crossing success was observed as significantly higher during oestrid fly season than during the mosquito period (Smith and Cameron, undated: 43). Caribou were observed using roads and gravel pads and the shade of pipelines and buildings as insect relief areas, which at other times they tended to avoid. Caribou were also observed using unvegetated gravel pads at more than twice the average number of those using vegetated pads of comparable size (BPX, 1990:10).

The crossing of pipeline corridors occurred more frequently during the insect season than before the onset of insect harassment. Some deflections occurred, but all groups eventually crossed. The incidence of deflection was highest for smaller cow or calf groups at corridors in which pipelines were less than 328 ft. from roads. Success tended to be higher at roads or pads without pipelines than at corridors with pipelines. Crossings of up to eight corridors were observed, although no successful crossings occurred with more than ten adjacent pipelines. The groups that crossed more than two pipelines were small (Johnson and Lawhead 1989:i-v, 34-68).

Large groups of caribou tended to split and detour around drill site pads during mosquito induced movements. However, during the oestrid fly harassment season, the caribou were attracted to pipelines, roads, and structures on pads, which presumably provided relief from insect harassment.

In the absence of insect harassment, caribou within 1,640 ft. of roads with no traffic spent more time feeding than did caribou 1,640 ft. and farther from roads with traffic. Avoidance of roads during periods of high traffic in the post calving period was noted by Roby in 1978 and by Dau and Cameron in 1986. Some research has indicated that roads which receive little use by humans need not be separated from pipelines (Curatolo and Reges 1985:35). Pipelines elevated at least five feet. have been shown to be effective except when they were in proximity to roads with moderate to heavy traffic (15 or more vehicles/hour). The Alaska Caribou Steering Committee concludes the most effective mitigation is achieved when pipelines and roads are separated by at least 500 ft. (Cronin et al., 1994:10). Lessees are encouraged in planning and design activities to consider the recommendations for oilfield design and operations contained in the final report of the Alaska Caribou Steering Committee.

A phenomenon frequently observed in the oilfields is congregation of caribou on gravel structures such as drilling and facility pads, and roads, and in shade created by pipelines or buildings. It has been suggested these areas are used for relief from insects, particularly from oestrid flies (Cronin et al., 1994:7 citing to Johnson and Lawhead, 1989, Lawhead, 1990). However, use of gravel pads as insect relief habitat may cause caribou to stop using preferred foraging areas, or it may allow caribou to remain in areas of higher quality forage, i.e., areas further inland. It has been suggested that coastal insect relief areas have lower quality forage (Cronin et al., 1994:7 citing to Roby, 1978).

If displacement from coastal insect-relief areas did occur during the construction of offshore oil and gas facilities, it would be temporary and disturbance reaction would diminish after construction is complete, provided that road systems are not too closely spaced. Routes that caribou take as they migrate to and from the coast depend on their location at the beginning and end of the insect harassment season (Cameron, et al., 1995). Whereas, calving caribou are highly sensitive to development, "female caribou will tolerate considerable surface development in summer, especially when passage under (or over) pipelines is possible" (Cameron et al., 1995, citing to Smith et al., 1994).

The CAH has grown considerably during the period of oilfield development, but lack of pre-development data makes assessment of effects of oilfield development difficult. Also the understanding of the population dynamics of the North Slope caribou herds is incomplete and no firm conclusions about the effects of oilfield development on reproductive success of the herd can be drawn. Based upon comparisons with other herds, there have been no apparent effects of oilfield development on the growth of CAH. This does not suggest that there may not be effects in the future, or that other herds under different ecological conditions may not be affected (Cronin et al., 1994:3). Findings of Cameron and Ver Hoef (1996) indicate a trend toward reduced calving activity in the Kuparuk River development area compared to the undeveloped area to the east of the Sagavanirktok River. However, seasonal restrictions on construction activities on developing oilfields could minimize disturbance-displacement of caribou from calving areas and summer range (MMS, 1998:IV-G-22). This disparity of use east and west of the Sagavanirktok River may be more pronounced in years of early snow melt, when caribou distribution tends to concentrate near the coastline (Cameron and Ver Hoeff, 1996).

Although new development within existing oilfields may increase cumulative effects, new technologies can reduce the infrastructure surface area (see Figure 5.2). The use of directional drilling to maximize the number of wells at drill sites, the centralization of power plants and utility systems, and the joint use of roads, pipeline corridors, and airports all contribute to less area impacted by oilfield infrastructure (Cronin, 1994:7 citing to Senner, 1989).

Cumulative reduction in habitat use near facility-construction projects (such as gravel mining, roads, pipelines, and drill pads) and caribou avoidance (cows with calves) of habitat areas with continuous high-levels of road traffic could have a long-term but local effect on the distribution of CAH caribou by displacing some portion of the herd from part of the summer calving range. The cumulative reduction in calving in summer habitat use by cows and calves of the CAH near oilfield facilities (such as road-pipelines with high traffic levels) may result in a long-term affect on caribou productivity and abundance. However, this potential effect may not be measurable (directly attributable to oil development) due to the great natural variability and productivity of caribou populations (MMS, 1998:IV-G-22).

Oil spills. If an offshore oil spill occurs in the open-water season, caribou that frequent coastal habitats could possibly be directly exposed to oil along the beaches and in shallow waters during periods of insect escape activities if the spill occurs at this time and washes into the area. Caribou that become oiled could die from toxic-hydrocarbon inhalation and absorption through the skin. Caribou may ingest oil-contaminated vegetation in these areas, resulting in significant weight loss and aspiration pneumonia leading to death. However, even in the severe situation, a comparatively small number of animals (perhaps a few hundred CAH caribou to a few thousand PCH caribou) is likely to be directly exposed to the oil spill and as a result, toxic-hydrocarbon inhalation absorption. This loss probably would be small for any of the caribou herds, and would be replaced within about one year (MMS, 1998:IV-G-21)

Caribou engaged in insect avoidance are unlikely to be grazing on coastal or tidal plants. In the event of an onshore oil spill that contaminated tundra habitat, caribou probably would not ingest oiled vegetation. They are selective grazers that are particular about the plants they consume (MMS, 1998:IV-G-21). In the event of a large oil spill contacting and extensively oiling coastal habitats with herds or bands of caribou during the insect season, the resultant boat, vehicular, and aircraft traffic, operating in the area during cleanup operations, is expected to cause disturbance and displacement of caribou (MMS, 1996: IV-B-52).

Natural gas development. The most likely effects of natural gas development in production in the planning area on caribou and other terrestrial mammals would come from vehicle traffic and construction activities associated with installation of onshore pipelines connecting production pads with the onshore processing facilities. Road traffic disturbance of caribou along the gas pipeline routes would be most intense during the construction, when vehicle traffic is highest, but would subside after construction is complete. Some displacement of calving caribou would be expected within 3 to 4 km of roads between oilfield facilities when they are located within caribou calving habitat. Caribou are likely to successfully cross the pipeline corridor within a short period of time (within a few hours or no more than a few days) during breaks the traffic, with little or no restrictions in general movements and no effect on overall caribou distribution and abundance. The construction of a gas pipeline would alter only a small fraction of the caribou range(MMS, 1997a:IV-K-2).

If a gas blowout occurred, the toxic plume likely would extend downwind about one mile, dissipate quickly, and last not much more than one day. If there were an explosion and fire, the wet tundra habitat of most of the Arctic Slope likely would not catch. The effects on terrestrial mammals and their habitats likely would be local and short-term (MMS, 1997a: IV-K-2). If a natural gas explosion and fire occurred on land or very near the coast, caribou in the immediate vicinity could be killed or displaced.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Disturbance -- If development occurs, pipelines must be designed and constructed to accommodate caribou movement and migration patterns. Above-ground pipelines must be elevated a minimum of five feet.. Ramps or pipeline burial may be required to facilitate caribou movement.

- Habitat Loss -- Lessees are advised that aircraft should avoid caribou concentrations to ensure access to insect relief and calving habitat. Lessees must avoid siting facilities in sensitive habitats and wetlands. Gravel mining must be limited to the minimum necessary to develop a field efficiently.

- Lessees are encouraged in planning and design activities to consider the recommendations for oilfield design and operations contained in the final report to the Alaska Caribou Steering Committee.

Other necessary measures can be imposed if and when lessees apply for the required permits to develop the leases. Moreover, the state has retained the right to cancel a lease if it is determined that continued operations will cause serious harm or damage to the biological resources, to property, or the environment.

d. Muskoxen

Muskoxen are present in low numbers in the Sagavanirktok drainage and other drainages west of the Canning River and are expanding their range. Small numbers occur in the Colville River Delta, in the area of the lower Itkillik River valley (Ott, 1997).Little is known regarding the influence of roads, traffic, and pipelines on muskox movements (Ott, 1996).

<u>Habitat Loss</u>. Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, housing and other infrastructure (Ott, 1996). Muskoxen have a high fidelity to particular habitat areas because of factors favorable to herd productivity and survival such as food availability, snow conditions, or absence of predators. Displacement from preferred habitat could have a negative effect on muskoxen populations. The magnitude of the effect is difficult to predict but would likely be related to the magnitude and duration of the displacement (USF&WS, 1987:126). However, given the small amount of onshore acreage, this sale is unlikely to affect muskoxen.

<u>Disturbance</u>. Muskoxen may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. Muskoxen remain relatively sedentary in the winter, possibly to conserve energy. The energetic costs associated with forced movements during winter may be as significant an impact as disturbance during calving. Mixed groups of muskoxen showed a greater sensitivity to fixed-wing aircraft in winter and during calving than in summer, fall, or during rut. Increased activity during exploration and development in muskoxen overwintering areas may have an adverse effect on muskoxen survival (Sousa, 1992). However, muskoxen may be able to habituate to aircraft and seismic disturbance (USF&WS, 1987:124). The cumulative effects on muskoxen, are likely to be local, within about 1 to 2 miles of oil exploration and development facilities and seismic survey activities, and generally short-term, with no significant adverse effects on their populations (MMS, 1997:IV-G-9).

<u>Oil Spills</u>. In general the effects of an oil spill on muskoxen would be similar to that of other terrestrial mammals. An oil spill may result in oil contamination of individual mammals in the immediate vicinity, contamination of habitats, and contamination of some local food sources. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of muskoxen, the presence of humans and traffic from vehicles and aircraft are expected to cause disturbance and displacement of muskoxen during cleanup operations.

<u>Effects of Natural Gas Development</u>. Impacts on muskoxen of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, muskoxen in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Mitigation Measures

The following summarizes applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Disturbance -- If development occurs, pipelines must be designed and constructed to accommodate muskoxen movement and migration patterns. Lessees are advised that aircraft should avoid muskoxen concentrations.

e. Brown Bear

Brown bears can be found throughout the Arctic region in varying densities. The lowest densities occur along the coastal plain. In the Arctic, brown bears are at the northern limits of their range. The availability of food is limited and their reproductive potential is low (ADF&G, 1986a:41). Although this is an offshore sale, a small amount of onshore acreage is included.

Habitat Loss. Direct habitat loss will result from construction of well pads, pipelines, roads, airfields, processing facilities, housing and other infrastructure. Quantifying the number of animals involved is difficult. Brown bears travel along the major river corridors and feed in riparian areas of the sale area. Siting facilities outside these areas will reduce potential impacts on brown bears (USF&WS, 1987:128).

Disturbance. Brown bears may be subject to disturbance from oil and gas activity. Primary sources of disturbance include seismic activity, vehicle traffic, and aircraft. Seismic activity which occurs in winter may disturb denning bears. Studies have found that radio-collared bears in their dens were disturbed by seismic activities within 1.2 miles of their dens. This was demonstrated by an increased heart rate and greater movement within the den. However, no negative effect, such as den abandonment, was documented (USF&WS, 1987:128).

Interaction with Humans. During exploration and development, human activity may attract foraging bears, especially to refuse disposal areas. Omnivores are attracted to food and food odors associated with human activity, and may become conditioned to non-natural food sources (Baker, 1987). This may pose a threat to human safety and the potential need to shoot "problem" animals. Bears can also be displaced by human land use activities.

Oil Spills. The potential effects of oil spills on brown bears include contamination of individual animals, contamination of coastal habitats, and contamination of some local food sources. Bears feed on fish concentrations at overwintering and spawning areas. Bears may also feed on beached marine mammal carcasses along the coast (Ott, 1997). If an oil spill contaminates beaches along the coast, bears are likely to ingest contaminated food sources. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of brown bears, the presence of humans and traffic from vehicles and aircraft are expected to cause disturbance and displacement of brown bears during cleanup operations.

Effects of Natural Gas Development. Impacts on brown bear of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, brown bear in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site thus, it is not likely that toxic fumes would affect animals except those very near to the source of the blowout.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting bears.
- Habitat protection -- lessees must avoid conducting exploration or development activities in the vicinity of occupied dens, or obtain approval for alternative mitigating measures.
- Avoidance of human/bear conflicts --- lessees are encouraged to prepare bear interaction plans.

f. Furbearers: Wolves, Wolverines, and Foxes

Fox populations vary in response to fluctuations in their natural prey sources, but a constant food supply could maintain the fox population at artificially high levels. This could cause near total nest failure of all waterfowl and shorebirds in the development area as foxes prey on eggs and young birds. Foxes and wolves are also noted for their rabies outbreaks, which increase when population densities are high, creating health risks to humans. Activity during exploration and development may attract foraging foxes and wolves, especially to refuse disposal areas. Wolverines apparently are not attracted to garbage (USF&WS, 1986: 534-

537). The Arctic fox population near development areas is expected to increase, which adversely may affect tundra-nesting birds (MMS, 1997a:IV-G-8).

Habitat Loss. Winter Arctic fox habitat is primarily along the coast and sea ice. Denning occurs up to 15 mi. inland. Red foxes also may den within 10 mi. of the coast but are generally found farther inland (Ott, 1996). Habitat destruction would primarily affect foxes through destruction of den sites. Placement of oil and gas infrastructure at or near den sites may either destroy den sites or cause foxes to den elsewhere (USF&WS, 1986:533-536). However, foxes have been known to use culverts and other construction materials for denning. Wolverines occur exclusively in remote regions where human activity is unlikely (USF&WS, 1987:127-128).

The effects of direct habitat loss on wolves would be negligible. The abundance of wolves is ultimately determined by the availability of prey. The ability of adults to provide food is the key determinant in wolf-pup survival. Reduction in prey species, such as caribou, could reduce wolf populations (USF&WS, 1987:126).

Disturbance. Wolves are unlikely to be disturbed by development. Wolves readily habituate to human activity. During construction of the Dalton Highway and TAPS, wolves readily accepted handouts from construction workers (USF&WS, 1987:127). Primary sources of disturbance are seismic activities and aircraft traffic. Helicopters generally invoke a stronger response from wolves and foxes than fixed-wing aircraft. Ice roads connecting well sites and supply areas would provide a source of vehicle disturbance. Impacts of seismic exploration and drilling on wolverines are unknown (USF&WS, 1986:535).

Oil Spills. The general effects of an oil spill on wolves, wolverines, and foxes are similar to that of other terrestrial animals. The potential effects of oil spills include contamination of individual animals, contamination of habitats, and contamination of some local food sources. Furbearers, particularly foxes, may be attracted to dead oiled wildlife at a spill site. Foxes may be attracted to the human activity at a spill site by the possibility of finding food or garbage. In the event of a large oil spill contacting and extensively oiling habitats with concentrations of wolves, wolverines and foxes, the presence of humans, along with vehicle and aircraft traffic are expected to cause disturbance and displacement of these animals during cleanup operations, with the possible exception of foxes.

Effects of Natural Gas Development. Impacts on wolves, wolverines, and foxes of a gas blowout would be similar to that of other terrestrial mammals. If a natural gas explosion and fire occurred on land or very near the coast, animals in the immediate vicinity could be killed or displaced. Blowouts of natural gas condensates that did not burn would be dispersed very rapidly at the blowout site. It is not likely that toxic fumes would affect animals except those very near the blowout.

Mitigation Measures

The following are summaries of some applicable mitigation measures. For the full text of mitigation measures see Chapter Seven.

- Habitat protection -- Exploration facilities must be temporary and must utilize ice roads and pads. Facilities may not be sited within riparian buffers utilized by furbearers.

- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting wolves, wolverines, and foxes.

g. Polar Bear

Potential impacts to polar bears include disruption of denning, attraction to areas of activity, ingestion of oil, oil contamination, and adverse interaction with humans.

Habitat loss. Construction of offshore oil and gas facilities such as pipelines, gravel islands, causeways, and production platforms are expected to have local effects on ice movements and fast ice formation around the structures. This will likely have a short term (less than one year) affect on polar bear distribution during construction activities (MMS, 1996: IV-H-13).

Disruption of Denning. The primary sources of noise disturbance would come from air and marine traffic. Seismic activities and low-frequency noise from drilling operations would also be a source of noise. Disturbance from human activities, such as ice road construction and seismic work, may cause pregnant females to abandon dens early. Early abandonment of maternal dens can be fatal to cubs. If some coastal denning areas in and some maternity dens on the sea ice were abandoned because of noise and human presence near denning areas, a short-term (one-generation) disturbance effect on polar bears is expected. Mitigation Measure 23 requires that operators avoid known bear dens by one-mile and report to USF&WS any newly discovered dens. In addition, polar bears are protected under the Marine Mammal Protection Act of 1972 (MMPA), and existing requirements under this act are expected to prevent excessive disturbance of the bears (MMS, 1996: IV-H-13 and MMS, 1998: IV-G-16). In Alaska, the protection of polar bears under the Act is the responsibility of USF&WS.

Oil contamination. Polar bears have been observed eating hydraulic fluid and other petroleum lubricants, and at least one bear in the Prudhoe Bay area died as a result of ingesting ethylene glycol antifreeze (Ott 1990). Polar bears are extremely sensitive to external and internal oil contamination. Bears may contact oil directly by swimming or wallowing in contaminated areas; and indirectly by scavenging oiled carcasses along the beach, by preying on oiled seals, or while maintaining their fur. It is important for polar bears to keep their fur clean to get the maximum benefit from its insulative qualities (MMS, 1993:12). In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of polar bears, the presence of humans, along with boat, vehicular, and aircraft traffic operating in the area is expected to cause disturbance and displacement of these animals during cleanup operations. However, polar bears may be attracted to a spill site by the presence of dead birds or other animals killed by the spill, or if they previously associated human activity with a food source (MMS, 1996: IV-B-26).

Adverse interaction with humans. Some polar bears could be killed as a result of human-bear encounters near industrial sites and settlements associated with oil and gas development. These losses represent a small source of mortality on the polar bear population that would be replaced by reproduction within one year. (MMS, 1998: IV-G-17). In 35 years of oil and gas operations there have been only two polar bears killed as a result of human-bear encounters.

Polar bears continually search for food. There is evidence that offshore drilling activity which creates cracks and leads in the ice attracts seals, which in turn attracts bears (Stirling, 1990). Once bears find a camp or industrial site, they will often enter to explore and search for food. If a bear receives a food reward, it is almost certain to return. They invariably investigate not only things that smell or act like food, but also novel sights or odors. Subadults are more likely to be food-stressed and, therefore, attracted to human activity more commonly than well-fed bears; they also are less likely to leave if a potential food source is present. Attractants include kitchen odors, deliberate feeding, accessible garbage, sewage lagoons, carcasses, industrial materials, and habitat alteration (MMS, 1993:13).

The MMPA prohibits the "taking" of marine mammals. "Take" is defined to mean "harass, hunt, capture, or kill," or an attempt to do so. By interpretation, taking is said to occur whenever human activity causes a polar bear to change its behavior. Disturbing a polar bear by trying to take a picture of it or scaring a bear away from a building are violations under the law (MMS, 1993:61) It is common practice for North Slope operators to prepare bear interaction plans. In addition, all personnel are required to undergo a training program which includes encountering wildlife (see Mitigation Measure 13).

In 1987, the NSB Fish and Game Management Committee and the Inuvialuit Game Council of Canada signed an agreement on polar bear management in the southern Beaufort Sea region. Among other measures, the agreement protects bears in dens and family groups with cubs, sets a hunting season, provides a framework for setting annual quotas for each country, and establishes a reporting system. The agreement is voluntary and has no regulatory backing (MMS 1993:63).

Taking a polar bear by individuals is legal under some circumstances, such as federal, state, or local government officials acting in the course of their official duties. Native Alaskans living on the coast are allowed to hunt polar bears for subsistence and handicraft purposes provided it is not done in a wasteful manner.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Disturbance -- Lessees are advised aircraft must avoid areas where species that are sensitive to noise and movement are concentrated.
- Waste management -- lessees must use appropriate methods of garbage and putrescible waste disposal to minimize attracting bears.
- Habitat protection -- lessees must avoid conducting exploration or development activities in the vicinity of occupied dens. Lessees are advised that certain areas are especially valuable for their concentrations of polar bears and must be considered when developing plans of operation.
- Avoidance of human/bear conflicts -- lessees are encouraged to prepare bear interaction plans.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

h. Bowhead Whale

Bowhead whales are currently protected under both the MMPA and the Endangered Species Act of 1973, and consequently are placed under the protective management of the National Marine Fisheries Service (NMFS). Generally, bowhead whales remain far enough offshore so as to be found mainly in federal waters. However, they may occur in state waters seaward of the barrier islands. Oil and gas activities may result in noise from aircraft, vessels, seismic surveys, dredging, drilling, and construction activities that occur within several miles of the whales.

Disturbance. Offshore exploratory drilling operations in U.S. waters of the Beaufort Sea have been limited by a seasonal drilling restriction since the first Beaufort Sea OCS sale in 1979. The Joint Federal and State Beaufort Sea Lease Sale imposed a seven month drilling seasonal drilling restriction on most leases to protect endangered bowhead whales. (Grogan 1990). The 1979 seasonal drilling restriction was modified in 1982 to generally restrict exploratory drilling during the fall bowhead migration. In 1985, two oil companies submitted requests for departures from the fall bowhead migration. These companies used drillships, which had not previously been used in the Alaskan Beaufort Sea. In response to this request the state, in consultation with the oil industry, federal government, and NSB, undertook a review of all information relevant to exploratory drilling activities and their effects on the bowhead whale. As a result of this review, the state established a seasonal drilling restriction policy in May 1986 which would apply to exploration activities on federal leases subject to the state's coastal consistency review, as well as offshore state oil and gas leases (Grogan 1990).

In October 1988, a notice requesting comments and suggestions for amendments to the May 1986 policy was distributed to the oil and gas industry, state and federal agencies, NSB communities and environmental interest groups. The state formed a working group comprised of personnel from ADNR, ADEC, ADF&G, and the NSB to review comments received. The state's review focused on noise impact studies that have been conducted to determine the impacts of industry activities on the bowhead whale (Grogan, 1990). A list of 26 studies, with a short summary of each, on the impact of industrial activities on migrating whales can be found in Appendix D.

The results of this review and of studies completed since the enactment of the May 1986 Policy have provided the state with a variety of information on the noise characteristics of drilling operations and related support craft activity, the unique characteristics of the acoustic environment of the Beaufort Sea, and the reactions of whales to various noise sources (Grogan, 1990). Bowhead whales use sound to gain information about their environment, and could be affected by noise production resulting from offshore exploration or development. Bowheads use low frequency calls for intraspecies communication. Sound travels well in water and an increase in sound levels could lead to a reduction in the communication and feeding ability of these cetaceans (Sousa 1990). These and other studies suggest that bowhead whales react to noise generated by drilling operations and associated support activities.

Studies of industrial noise characteristics also show that drilling from floating platforms, and the ice management activity required to protect floating platforms, transmit more noise in the water column than drilling from bottom-founded structures and natural and gravel islands. In addition, aircraft and vessel activities associated with both floating and bottom-founded structures can generate significant noise.

Studies conducted in the Canadian Beaufort Sea provide some evidence that bowhead whales have been avoiding the main industrial area (Richardson et al. 1985). However, another study suggests that the distribution and abundance of zooplankton and the variable distribution of ice cover may have more effect on the whales, regardless of noisy industrial activities (LGL, 1983). Studies in the Alaskan Beaufort Sea by BBN Laboratories and LGL Limited (Miles et al. 1987) also indicate that bowhead whales may respond to industrial noise at greater distances than previously thought, with drillships and related support vessels creating the largest potential zone of disturbance. Moreover, whaling captains from Alaskan North Slope communities have observed that as nearshore vessel traffic has increased in the Beaufort Sea during fall whaling, whales have been displaced further offshore, thus making them less accessible to the whaling crews, and negatively impacting fall whaling.

Surveys demonstrated that some bowheads may respond to industrial noise by course deviation at distances as great as 6 to 12 miles from the point of origin, depending on source and numerous factors affecting noise propagation (Davis 1987, Miles et al. 1987). Collective observations of whaling captains indicate that pods of migrating bowhead whales can be displaced (diverted away from shore) as much as 30 miles from their normal migratory path, and that the whales begin their diversion at distances of up to 35 miles from an active seismic operation (MMS, 1997).1 However, another study shows that the whales did not deter from their migratory pattern even when only a long, narrow lead of 656 ft. was available and they had to pass a projector emitting drillship noises. They only altered their pattern by passing the projector on the other side of the lead (Richardson et al 1991). Several reports from drillships show that temporary displacement may occur at the direct approach of a boat or aircraft, but the bowheads continue their patterns of feeding and migratory behavior soon after the disturbance has passed, and even in the presence of drillship activity.

Studies conducted in recent decades have shown that bowhead whales do respond to vessels by moving away, or altering their surfacing and diving patterns. However, evidence is not conclusive to support that permanent changes to feeding or migratory patterns have occurred (Fraker et al 1982, Davis 1987). These biologists believe that little information is available showing that bowheads abandon an area, travel far, or remain disturbed for extended periods after a ship passes. In terms of displacement from areas with heavy traffic, past observations and studies demonstrate that various cetacean species react differently to long-term disturbances, and consequently, bowhead whale responses to repeated disturbances cannot be predicted accurately. However, a current report states that "The most intense, and potentially most disturbing, human activities are subsistence whaling, commercial vessel traffic, and marine seismic activities," (LGL Limited, 1991).

Behavioral studies have suggested that bowhead whales habituate to noise from distant ongoing drilling, dredging, or seismic operations, but there still is some apparent localized avoidance. There is insufficient evidence to indicate whether or not industrial activity in an area for number of years would adversely affect bowhead use of the area, nor has there been documented evidence that noise from OCS operations would serve as a barrier to migration (MMS, 1998:IV-G-11). Overall, bowhead whales exposed to noise-producing activities most likely will experience temporary, non-lethal effects (MMS, 1998:IV-G-12).

Behavioral disturbance to marine mammals is considered to be "take by harassment" under the MMPA. All open-water seismic and other operations, like drilling programs that have the potential to "incidentally take" marine mammals, including the bowhead whale, have monitoring programs. All seismic and other offshore energy projects undergo multi-agency review that includes NMFS. NMFS is notified of and receives copies of all geophysical exploration permit applications received by the division. The Alaska Region office routinely participates in seismic monitoring and mitigation plan reviews. During these reviews, specific recommendations for monitoring programs are made. Under the MMPA, Incidental Harassment Authorizations (IHAs) can be issued by NMFS that authorize unintentional disturbance but not serious injury or mortality. Disturbing or taking bowhead whales without an IHA would violate the MMPA and lessees are reminded in Lessee Advisory 5c that they must comply with the provisions of the Marine Mammal Protection Act of 1972 as amended.

In addition, Mitigation Measure 17 provides that any tract or portion thereof in the proposed Beaufort Sea Areawide Lease Sale area may be subject to seasonal drilling restrictions. The measure provides specific seasonal drilling restrictions for exploratory drilling operations from bottom-founded and floating drilling structures and natural and man-made gravel islands. The effect of this mitigation measure is to prevent whales from being disrupted during their migration and when they are most likely to be hunted.

Seismic surveys and industrial noise from offshore drilling and associated icebreaker support do not cause either serious injury or mortality, but can affect individual whale behavior. NMFS requires that seismic programs conducted under IHAs include provisions to monitor for marine mammals and to shut down airguns when mammals are detected within designated safety radii.

Geophysical exploration activities are governed by 11 AAC 96 and are not affected by leasing. Lessee Advisory 4 does advise that lessees or non-lessee companies may propose various operations, which include seismic surveys, in the sale area. Restrictions on geophysical exploration permits, whether lease-related or not, will depend on the size, scope, duration, and intensity of the proposed project and on the reasonably foreseeable effects on important species, specifically marine mammals.

Drilling and Production Discharges. The types of material discharged from drilling operations include drilling muds and cuttings. The discharges create plumes of the material that disperse rapidly in the water column. Most drilling muds and cuttings land on the sea bottom relatively close to the discharge point, depending on the water depth and current. Discharged drilling muds and cuttings during drilling operations are not expected to cause significant effects either directly through contact or indirectly by affecting prey species. Any effects would be very localized around the drill rig due to rapid dilution/deposition of these materials. The preferred method for disposal of muds and cuttings from oil and gas activities is by underground injection (Mitigation Measure 20). Discharge of produced waters into open or ice-covered marine waters of less than 33 feet in depth is prohibited (Mitigation Measure 21). Drilling muds and cuttings may cover small areas of the seafloor that support epibenthic invertebrates used for food by bowhead whales. However, the effects of the discharges are expected to be negligible to bowhead whales because the sale area is in relatively shallow near-shore waters outside the main migration routes. Also, bowhead whales feed primarily on pelagic zooplankton, and the areas of sea bottom that are impacted would be inconsequential in relation to the available habitat (MMS, 1998:IV-B-19).

Causeways. Although the post-construction environmental effects of continuous solid fill causeways are the subject of differing opinions, it is generally accepted that nearshore causeways have little or no effect on marine mammals. Bowhead and gray whales have been sighted in nearshore areas of the Arctic coast, but they normally inhabit deeper water farther from shore and as experience with the Endicott and West Dock causeways near Prudhoe Bay has shown, the deeper water food sources eaten by whales as well as ringed seals are not affected by the construction and maintenance of a causeway (USACE, 1984:226). Furthermore, because noise propagates poorly in shallow waters where causeways are generally utilized, noise disturbance is not expected to affect the migration patterns or food sources of marine mammals in the sale area. Mitigation Measure 11 discourages the use of continuous-fill causeways and prohibits significant alterations to nearshore oceanographic circulation patterns. This measure imposes design parameters that ensure natural salinity and temperature regimes that may affect fish distribution are not altered. Environmentally preferred alternatives for field development include use of buried pipelines, onshore directional drilling, or elevated structures.

Causeways are not expected to affect whale migration or feeding because they are in-shore structures in shallow water.

Oil spills. Primary concerns about the potential effects of oil spills on bowheads in the Beaufort Sea include: 1) accumulation of oil in eroded areas of the bowhead's skin and around the eye leading to noxious effects from surface contact with hydrocarbons; 2) accidental ingestion or inhalation of quantities of oil while feeding, possibly resulting in lethal or sublethal effects including gastrointestinal tract obstructions; 3) fouling of baleen with oil resulting in reduced filtering efficiencies; and 4) destruction or contamination of critical food sources from acute or chronic oil pollution.

Bowhead whales have not been observed in the presence of an oil spill, so it is uncertain if they can detect oil or would avoid surface oil. If a bowhead came in contact with spilled oil it is unlikely that the oil would stick to the smooth areas of bowhead skin, but might adhere to rough areas on the skin surface. If bowheads left the oiled area it is likely that most of the oil would wash off within a short time. Bratton et al. (1993) concluded that bowhead encounters with fresh or weathered oil present little topological hazard to the skin of a bowhead (MMS, 1996: IV-B-42).

Bowheads would most likely contact oil as they surfaced to breathe. Although unlikely, inhalation of oil vapor might cause intoxication, irritation of the mucus membrane and respiratory tract and the absorption of volatile hydrocarbons into bloodstream. These would likely be rapidly excreted. Vapor concentrations that could be harmful to whales would likely dissipate within a few hours. However, whales exposed to toxic vapors within a few hours of the oil spill could suffer pulmonary distress and possible death. Generally, only a few whales would likely be affected at any given time (MMS, 1996: IV-B-43).

Measures included in this sale in addition to normal oil spill prevention plan requirements (C-plans), further avoid, reduce, or minimize oil spill risk to bowhead whales. Mitigation Measure 7 ensures that pipelines are designed to prevent accidental rupture or discharge from geophysical hazards, like ice scouring. This measure further reduces risk of an oil spill by prohibiting the transport of crude by tanker or any other means from offshore production sites once a subsea pipeline has been installed.

As prescribed by Mitigation Measure 17, any tract or portion thereof in the Beaufort Sea areawide sale area may be subject to the March 1990 Beaufort Sea Seasonal Drilling Policy. This policy prohibits well drilling during summer when cleanup would be most difficult and bowhead whales would be most vulnerable to an oil spill. Lessees conducting drilling operations during periods of broken ice (June to November) must participate in an oil spill research program; be trained and qualified in accordance with Minerals Management Service standards pertaining to well-control equipment and techniques; and have an oil spill contingency plan that meets the requirements for in situ igniters, fire resistant boom, relief well plans, and a decision process for igniting an uncontrolled release of oil. These measures serve to minimize the potential for an oil spill occurring while bowhead whales are present in the sale area.

If feeding bowheads contacted spilled oil, the baleen hairs might be fouled. Repeated baleen fouling over an extended period of time might result in reduced food intake which might affect the health and survival of bowheads. There is a potential pathway for the accumulation of petroleum hydrocarbons in animals that feed on contaminated zooplankton, including a primary food species of the bowhead, Calanus hyperboreus (Bratton et al., 1993:723). Bowheads might ingest some tar balls or large blobs of oil along with oil-contaminated prey while feeding. While the fate of an ingested tar ball is difficult to ascertain, toxic chemicals in tar could obstruct digestive passages resulting in acute illness or death (Bratton et al., 1993:724, citing to Tarpley, 1985). Production of zooplankton, the major food source of bowheads, would not be permanently affected by an oil spill. The amount lost even in a large spill would be negligible in comparison with the plankton resources available in the bowhead whale summer feeding grounds (MMS, 1996: IV-B-43). As discussed above, Mitigation Measure 7 ensures that pipelines are designed to prevent accidental rupture or discharge. In addition, Mitigation Measure 17 prohibits drilling during periods of broken ice in summer when cleanup would be most difficult.

Past studies found that effects from oil would be of local and limited distribution (Geraci and Aubin 1982, Richardson et al 1987). More specifically, that: (1) the effects of oil on important feeding grounds would be local and of limited duration; (2) there is growing evidence that bowheads feed over a large area in the Beaufort Sea; (3) the fouling of baleen by oil would have a limited, short-term influence on the filter/feeding process; (4) lethal effects from ingestion of oil are unlikely unless aspiration of vomitus occurs, which could also cause sublethal lung damage; and (5) evidence to date shows that while oil may cause some short-term effects on cetacean skin, such effects are not lethal.

It is unlikely that an oil spill entering the substrate would have any population-level effect on either the bowhead whale food source or the whale itself. First, primary bowhead whale feeding areas are outside of the sale area (See Chapter Three). Second, if oil entered the substrate, some specie communities would require years to recover. These species include epibenthic organisms and the number of organisms affected would be limited to the area oiled. However, copepods and euphausids are the principal foods of bowhead whales, not epibenthic species. Copepods are nearly microscopic free-living zooplankton and their entire life cycle can be completed within two weeks. Euphausids are a small group of pelagic (in water column) crustaceans, commonly called krill. Epibenthic invertebrates such as mysids and gammarid amphipods occasionally are dominant foods, but are usually consumed incidentally while whales are feeding on copepods and euphausids. Third, the Western Arctic bowhead whale stock is healthy and growing approximately 3.2 percent/year and is therefore less vulnerable to mortality associated with an oil spill. In conclusion, an oil spill could not create a significant impact on the Beaufort Sea bowhead population.

Effects of Natural Gas Development. The most likely effect of natural gas development and production on whales would come from air traffic to and from production platforms and support facilities (probably at Deadhorse) and from platform and offshore-pipeline installation. However, the effect of this noise disturbance is likely to be very brief and result in only a temporary displacement of some marine mammals along the flight paths (MMS, 1998:IV-HL-11).

The effect of installing gas-production platforms and laying gas pipeline would be similar to the effect of installing oil production platforms and laying oil pipelines. Effects would be minimal or avoided since all construction occurs in winter when whales are not present. Construction is temporary lasting one to three seasons, thus any impacts during summer months would be near the gas production platforms along the pipeline routes. Although this effect could increase the habitat alterations, and possibly alter the availability of some food supplies, changes are expected be short-term (less than one year) and local (within about 1.6 km of the activity) (MMS, 1998:IV-HL-11).

If a natural gas blowout occurred with a possible explosion and fire, whales in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would disperse very rapidly from the blowout site; it is not likely that these pollutants would effect any whales except individuals present in the immediate vicinity of the blowout. For any whales to be exposed to high concentrations of gas vapors or condensates, the blowout would have to occur below or on the surface of the water, not from the top of the platform or gravel island (MMS, 1998:IV-HL-11). A blowout that results in an oil spill is extremely rare and has never occurred in Alaska. However, natural gas blowouts have occurred. Blowout preventers, which immediately close off the open well to prevent or minimize any discharges, are required for all drilling and work-over rigs and are routinely inspected by the AOGCC.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Migration Disturbance -- lessees must comply with seasonal drilling restrictions in identified subsistence whaling zones and coordinate with local whaling groups, communities, and other interested parties.

- Lessees are advised of the times and areas where subsistence whaling activities generally occur and that measures may be imposed on geophysical exploration in the vicinity of bowhead migration.

- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

- Permanent facility siting within three miles of Cross Island and in state waters between the west end of Arey Island and the east end of Barter Island is prohibited.

Adverse effects on bowhead whales will be minimized by the measures described above. In addition to bowhead whales, species such as beluga, humpback, fin, killer and gray whales may occasionally be present in the vicinity. With the exception of beluga whales, occurrences of these other whales are rare since these waters are at the extreme margin of their range (USF&WS, 1987). These other whales will also be protected by the measures developed to minimize disturbance to bowhead whales.

i. Other Marine Mammals

The majority of the North Pacific walrus population occurs west of Barrow, although a few walrus may move east throughout the Alaskan portion of the Beaufort Sea to Canadian waters during the open water season. Spring and summertime oil and gas exploration and development activities in the sale area and elsewhere in the Beaufort Sea could disturb ringed, spotted and bearded seals and walrus and, depending on other human activity in the area, could ultimately contribute to some limited displacement. Seals are commonly distributed throughout the sale area, and populations vary considerably with seasonal weather changes.

Habitat Loss. Some pinnipeds could be temporarily displaced by construction activities associated with offshore platforms, pipeline trenching, causeways, and gravel islands. Onshore development near the coast could also disturb a small number of pinnipeds. However, the amount of displacement is likely to be very small in comparison with the natural variability in seasonal habitat use and is not expected to affect seal populations. Effects are likely to be one year or season or less, with any disturbance of pinnipeds declining after construction activities are complete (MMS, 1996:IV-B-30).

Disturbance. The primary sources of noise and disturbance of pinnipeds would come from marine traffic, air traffic, and seismic surveys. A secondary source would be low frequency noises from drilling operations. Boat traffic could disturb some pinnipeds concentrations. However, such traffic is not likely to have more than a short-term (a few hours to a few days) effect. Helicopter traffic is assumed to be a source of disturbance to pinnipeds hauled out along the beaches of the Colville River Delta and other haulout areas. Such brief occasional disturbances are not likely to have any serious consequences. Noise and disturbance from seismic operations could cause a brief disturbance response from seals and walrus. However, the affected animals are likely to return to normal behavior patterns within a short period of time (MMS, 1996:IV-B-29).

Oil Spills. Direct contact with spilled oil by pinnipeds may result in some mortalities. If newborn seal pups come in contact with oil, they may lose their thermo-insulation capabilities and die from hypothermia. Adults may only suffer from temporary eye and skin irritations. The specific effects would depend on many factors, including the seal's age and health. Seals are known to be capable of metabolizing as well as excreting and absorbing oil. In general, deaths from contact with oil among adult seals are most likely to occur during periods of high natural stress such as during the molting season or times of inadequate food supply, or if affected by disease (MMS, 1987). The measures outlined above for whales will also protect seals and will reduce the likelihood that oil spills or human activity associated with oil and gas exploration and development activities could adversely affect marine mammals such as ringed seals. In the event of a large oil spill contacting and extensively oiling coastal habitats with concentrations of pinnipeds, boat, vehicular, and aircraft traffic operating in the area is expected to cause disturbance and displacement of pinnipeds during cleanup operations. If operations occurred in the spring they would contribute to increased stress and reduced pup survival of seals (MMS, 1996:IV-B-26).

Effects of Natural Gas Development. If a natural gas blowout occurred with a possible explosion and fire, ringed, spotted and bearded seals, and walrus in the immediate vicinity of the blowout could be killed, particularly if the explosion occurred below the water surface. Natural gas and gas condensates that did not burn in the blowout would be hazardous to any organisms exposed to high concentrations. However, natural gas vapors and condensates would disperse very rapidly from the blowout site. It's not likely that these pollutants would affect any marine mammals except individuals present in the immediate vicinity of the blowout. For this to happen the blowout would have to occur below or on the surface of the water, not from the top of the platform or gravel island (MMS, 1998: IV-HL-11).

The effects of natural gas development on marine mammals are likely to be short-term (less than one year) and local (within about 1.6 km) of blowouts, noise in disturbance, and platform and pipeline-insulation activities (MMS, 1998: IV-HL-11).

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Protection from seismic activities -- Lessees are advised that using explosives in open water areas during offshore seismic activities is prohibited.
- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Lining, diking and buffer zones are required to separate oil storage facilities from marine and freshwater supplies.

4. Effects on Subsistence Uses

Traditional subsistence uses include bowhead and beluga whaling; walrus, polar bear and seal hunting; brown bear, caribou, musk ox, and moose harvesting; hunting and trapping of furbearers, such as wolf, fox, weasel, wolverine, and squirrel; the taking of migratory waterfowl and their eggs; fishing for whitefish, char, salmon, smelt, grayling, trout, and burbot; collecting berries, edible plants, and wood; and producing crafts and tools made from these wild resources. Subsistence also includes social activities of consuming, sharing, trading and giving, cooperating, teaching and celebrating among members of the community.

Direct effects of oil and gas exploration and development on subsistence uses may include increased access and land use limitations, less privacy, immediate effects of oil spills, and potential increase in wage earning opportunities to supplant subsistence activities. Indirect effects include the potential reduction in local fish and wildlife populations due to development; increased travel distance and hunting time required to harvest resources; potential reductions in harvest success rates; increased competition for nearby subsistence resources; improvements in community transportation, trade, and utilities infrastructure; and increased revenues to local government through petroleum revenue taxes.

Alteration of the physical environment may affect migration, nesting, breeding, calving, denning and staging of animals which are sensitive to oil and gas development activities. For example, noise propagation from floating seismic vessels, support ships, and icebreakers is known to alter the behavior of some individual bowhead whales. While this may not adversely impact the whales, or have any population-level effects on the migrating Beaufort Sea stock, certain individuals may show avoidance and subsequently travel further away from the seacoast. This could result in whaling teams having to travel farther offshore in order to capture that particular whale. Such avoidance behavior is reduced or avoided by observing measures that restrict the time and position of seismic and drilling activities.

Other physical alterations of the environment from post-sale activity could affect subsistence. If a road adjacent to a pipeline was heavily traveled (as in during a project's construction phase), caribou may avoid the area of higher vehicular activity. The result could be that a subsistence hunter may have to travel farther from the village in order to capture the affected caribou. Another example might be the industrial use of water, which could affect the drainage pattern of a river distributary, thereby affecting a particular anadromous fish run, which happens to be a part of a commercial or subsistence fishery.

Any activity that has the potential to harm fish or wildlife has the potential to affect subsistence. Mitigation measures have been designed to avoid, reduce or minimize biological alterations in the sale area. Reducing impacts to subsistence resources from oil and gas development is a primary goal in lease sale planning. The objective of protecting subsistence uses lies in protecting cultural and biological resources (See previous subsection of this chapter and the following subsection).

The effects of an oil spill on marine mammals and fish is the most feared adverse impact from oil and gas development offshore. Residents are concerned that the technology does not exist to clean up a major spill, which, regardless of the time of year, would not be possible to fully clean up and which could have incalculable effects on subsistence resources. Residents, having witnessed decades of sea-ice activity, continue to question the structural integrity of drill rigs in the face of tremendous ice forces. An older resident observed sea ice suddenly rise up a 20 ft. bluff, threatening homes in Barrow (MMS, 1996:V-141).

Another concern feared by local residents is impacts on bowhead whales and subsequent increases in the cost and danger of whaling ventures. For a discussion of impacts on bowheads, see previous subsection. Whaling captains have testified that during seismic and drilling rig operations, whales move further offshore and that when an individual whale avoids oil and gas activities, it may signal other whales, causing individual whales to move further offshore in a given season. Caribou may signal each other in the same manner depending on group size. Birds also communicate with visual and auditory cues.

Fish, such as Arctic cisco or broad whitefish, which utilize portions of the sale area for migration and feeding, could also be affected by excessive disturbances from some oil and gas activities, such as causeways or oil spills. These fish could be directly damaged, or otherwise made less accessible to subsistence fishers. The inability to harvest seals or other marine mammals due to avoidance behavior or loss of supporting habitat could affect subsistence uses other than for food consumption, such as use of seal skins for covering umiaks, or skins and furs for clothing and handicrafts.

Community well-being depends on the continued use of subsistence resources because they are culturally and economically significant. The subsistence way of life, with its associated values of sharing food and its influence on the extended family and traditional knowledge, is considered an integral part of being Inupiat (Kruse and others 1983:185). In addition to this cultural component, subsistence is the direct source of economic well being for NSB residents. Subsistence resources enter into household income as a food source that does not have to be purchased. A loss of subsistence resources would be a loss of income for the entire community (MMS, 1996:IV-B-57).

Previous subsections of this chapter describe the potential impacts to fish and wildlife populations due to habitat loss, disturbance, oil spills, and gas blowouts. They also summarized the mitigation measures that will be imposed on the sale area to maintain fish and wildlife populations. Additional site-specific and project-specific mitigation measures may be required later if exploration and development take place.

<u>Access</u>. As new discoveries are made, the number of development-related facilities will increase, and portions of the developed areas could be closed to public access, reducing the area available for subsistence activities. If subsistence hunters are displaced from traditional hunting areas they might have to travel greater distances and spend more time harvesting resources. At the same time, increased public access to hunting, fishing, and trapping areas, due to construction of new roads, could increase competition between user groups for subsistence resources. If competition for scarce resources, like moose, on the North Slope were to increase, game managers would restrict non-subsistence hunting and fishing. Management practices to restrict non-local resident hunting are in place for Game Management Unit 26. See Chapter Four for a description of sport hunting and fishing in the sale area.

The development of more transportation corridors in support of oil development on the North Slope could increase human access to the North Slope caribou herds, which could result in increased hunting pressure and perhaps over-harvest of some herds. Noise and disturbance associated with caribou harvest are not expected have any significant effects on caribou movements across North Slope roads. Caribou have continued to cross roads and highways, even when subject to heavy hunting pressure and increased noise associated with hunting (MMS, 1998:IV-G-22).

Impacts on subsistence usage from oil and gas exploration, development, production, and transportation depend on mitigation measures, operator and lease holder company policies, and all applicable wildlife conservation and protection laws. All plans of operations proposals (approval of these plans is required before any exploration or development activity can begin) are reviewed for consistency with applicable laws, including the Alaska Coastal Management Program (ACMP) and North Slope Borough Coastal Management Plan (NSBCMP). The entire sale area is located within the NSB Coastal Management Zone. The NSBCMP Standards for Development Policy 2.4.3(d) states, "Development shall not preclude reasonable subsistence user access to a subsistence resource." For a complete review of this sale's consistency with coastal management plans, see the Alaska Coastal Management Program Consistency Analysis Regarding Proposed Oil and Gas Lease Sale Beaufort Sea Areawide 1999.

ACMP standards are applied at the lease sale stage and they will be reapplied at all future phases. Under 6 AAC 80.120, Coastal Management Districts must identify areas in which subsistence is the dominant use of coastal areas and resources. Under (d) of that section, a study of the possible adverse impacts of the proposed potentially conflicting use or activity upon subsistence usage must be conducted for these designated areas and safeguards must be appropriated to protect the subsistence usage priority. This applies when an activity, use, or project is actually proposed.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Whale and other animal disruption -- lessees must comply with seasonal drilling restrictions in identified subsistence whaling zones, and coordinate activities with local whaling captains. Copies of seismic permit applications will be provided to the NSB, AEWC, and potentially affected subsistence communities for comment. Lessees are advised that interfering with reasonable access to subsistence resources violates the ACMP and NSB Municipal Code. Aircraft must avoid sensitive bird habitat, and vertical and horizontal buffers separating aircraft from waterfowl, caribou, and muskoxen may be required. Identified sensitive habitats must be avoided and potential adverse impacts considered in operations planning.

- Unrestricted access -- No restriction of public access to, or use of, the lease sale area due to oil and gas activity will be permitted, except within the immediate vicinity if drill sites, buildings and other related facilities. Any area of restricted access must be justified in the plan of operations.

- Whale Harvest Protection -- Permanent facility siting on Cross Island is prohibited unless approved by the NSB. Permanent facility siting within three miles of Cross Island and in state waters between the west end of Arey Island and the east end of Barter Island will be prohibited unless the lessee demonstrates to the satisfaction of the Director, in consultation with the NSB, that the development will not preclude reasonable access to whales as defined in NSBCMP Policy 2.4.3(d) and in NSBMC 19.79.050(d)(1) and as may be determined in a conflict avoidance agreement if required by the NSB. Lessees are advised that interfering with reasonable access to subsistence resources violates the ACMP and NSB Municipal Code.

  Lessees are advised that the NSB may, under its authorities, require the lessee to enter into a Conflict Avoidance Agreement with the AEWC prior to applying for a NSB rezoning or development permit for the siting of permanent facilities in state waters. If the Director permits permanent facility siting in state waters within three miles of Cross Island, subject to the subsistence harvest protection and whale harvest protection mitigation measures, the NSB has advised the state they will require a Conflict Avoidance Agreement.

- Oil Spill Prevention and Response -- In addition to addressing the prevention, detection, and cleanup of releases of oil, contingency plans (C-Plans) include methods for detecting, responding to, and controlling blowouts; the location and identification of oil spill cleanup equipment; the location and availability of suitable alternative drilling equipment; a plan of operations to mobilize and drill a relief well.

- Harvest conflict resolution -- lessees must cooperate with agencies and the public to avoid conflicts by selecting alternative sites or implementing seasonal restrictions on certain activities, and by siting permanent facilities a minimum distance from rivers. Prior to initiating any activity which may disrupt subsistence harvesting, lessees must consult with the affected community before plans of operation may be approved. Lessees are advised to consult with the NSB and the local communities during planning of operations.

- Community participation -- Lessees are encouraged to bring local residents into their operations planning process. Residents can provide critical input and traditional knowledge to operations and oil spill prevention and response plans. Community representation on management teams facilitate understanding and the transfer of information between the lessee and the residents.

5. Effects on Historic and Cultural Resources

Cultural and historic resources are those sites and artifacts having significance to the culture of Arctic people. Historic and cultural sites are those identified by the National Register of Historic Sites, and include those identified in the NSB Traditional Land Use Inventory (TLUI), by the Commission on Inupiat History, Language and Culture, and sites identified in other published studies. Many places, such as ancient village locations along the tributaries of the Colville River, which contain archaeologically important relics, continue to be used today. Additional information regarding important cultural and historic sites can be obtained by contacting the North Slope Borough Planning Department. See also Hoffman, et al., (1988), Jacobson and Wentworth (1982), the Nuiqsut Cultural Plan (NSB, 1979b), and the NSBCMP Background Report and Coastal Resource Atlas (NSB 1984:b) and the NSB Municipal Code (NSBMC 19.70.050(E).

"It is the policy of the state to preserve and protect the historic, prehistoric and archeological resources of Alaska from loss, desecration and destruction . . . " AS 41.35.010. Existing statutes, which apply to both known sites and newly discovered sites, are:

- AS 41.35.200(a) prohibits a person from unlawfully appropriating, excavating, removing, injuring or destroying any historic, prehistoric, or archeological resources of the state. "Historic, prehistoric, or archeological resources" include" deposits, structures, ruins, sites, buildings, graves, artifacts, fossils, or other objects of antiquity which provide information pertaining to the historical or prehistorical culture of people in the state as well as to the natural history of the state." AS 41.35.230(1). Violators of this statute are subject to criminal (misdemeanor) penalties and civil penalties (fines up to $100,000 per violation). AS 41.35.210, 215.

AS 41.35.200(c) prohibits the unlawful destruction, mutilation, defacement, injury to, removal of or excavation of a grave site, tomb, monument, gravestone, or other structure or object at a grave site, even if the grave site appears to be abandoned, lost, or neglected. Violators of this statute are subject to the same penalties listed above for AS 41.35.200(a) [historic, prehistoric and archeological resources].

Under NSB Land Management Regulations, any proposed development project shall not impact any historic, prehistoric or archaeological resource prior to an assessment of that resource by a professional archaeologist (NSBMC 19.50.030(F)). Additional protection from development disturbance is assured under NSBCMP Policy 2.4.3 to "sites eligible for inclusion in the National Register; or sites identified as important to the study, understanding, or illustration of national, state or local history or prehistory..." Finally, under NSB Land Management Regulation 19.70.050(F), "Development shall not significantly interfere with traditional activities at cultural or historic sites identified in the NSBCMP. These provisions give the NSB significant authority to protect both cultural historic resources, and current subsistence uses of these sites.

Potential impacts could occur in either the exploration, development, or production phases, but are more likely to occur if development occurs. Impacts include disruption of culture and disturbance of historic and archeological sites.

Historic use and archeological sites. The ADNR, Office of History and Archaeology has researched the available sources and found 14 known historic and archeological sites onshore within the sale area. The setting of the sale suggests a high potential for the discovery of additional sites.

Many onshore sites along the coast are currently eroding. Storm surges during the summer and fall open water season have caused rapid coastline erosion. The greatest effect on archeological resources in the Beaufort Sea is from natural processes such as ice gouging, bottom scour, and thermokarst erosion. Because the destructive effects of natural processes are cumulative in nature, they have had and will continue to have a high-level of effect on archeological resources in the sale area (MMS, 1998:IV-G-28).

Disturbance. Impacts may be caused by surface vehicle traffic, construction activity associated with drill pads, roads, airstrips, pipelines and processing facilities. Damage to archaeological sites can include direct breakage of cultural objects, damage to vegetation and thermal regime leading to erosion and deterioration of organic sites, and shifting or mixing of components in sites resulting in loss of association between objects. Crews at archeological or historic sites could damage or destroy sites by collecting artifacts (USF&WS, 1986:537-539). Mitigation Measure 12 requires that lessees conduct an inventory of prehistoric, historic, and archaeological sites prior to activity. In the event that objects are found, the site must be protected and reported immediately to the Director so that the site or object can be preserved. In addition, all personnel are to be trained in the applicable laws protecting cultural and historic resources.

Oil Spills. Oil spills can have an indirect affect on archaeological sites by contamination of organic material which would eliminate the possibility of using carbon dating methods (USF&WS, 1986:537). The most important understanding obtained from past large-oil-spill cleanups is that archeological resources generally were not directly affected by the spilled oil. Following the Exxon Valdez Oil Spill (EVOS), the greatest effects came from vandalism, because more people knew about the locations of other resources and were present at the sites. Various mitigation measures used to protect archeological sites during oil-spill cleanup are avoidance (preferred), site consultation and inspection, onsite monitoring, site mapping, artifacts collection, and cultural resource awareness programs (MMS, 1998:IV-G-28). Fortunately, the detrimental effects of cleanup were slight during EVOS oil spill because the work plan for cleanup was constantly reviewed, and cleanup techniques were changed as needed to protect archeological and cultural resources (Bittner, 1993).

Cumulative effects on archeological sites from oil and gas exploration, development and production are expected to be low. In the event an increased amount of bottom-disturbing activity takes place, in-place, state and federal laws and regulations should mitigate effects to archeological resources. The expected effect on archeological resources from an oil spill is uncertain, but data from EVOS indicated that less than three percent of the resources within a spill area would be significantly affected (MMS, 1998:IV-G-28).

Effects of Natural Gas Development. Disturbance to historical and archeological sites might occur as a result of onshore activity associated with accidents such as a gas blowout or explosion. Cleanup after such accidents could result in disturbance by cleanup workers in the vicinity of the accident site. Archaeological resources in the immediate vicinity of the blowout might be destroyed.

Prehistoric and historic archeological resources could be affected by activities associated with a potential installation of gas-production platforms, pipelines and any other bottom disturbing activities. The expected effect on archeological resources should be low because of the requirement for review of side-scan sonar data prior to any energy development activities (MMS, 1998:IV-H-12).

Mitigation Measure

The following are summaries of some applicable mitigation measures. For the full text of mitigation measures see Chapter Seven.

- Education -- lessees are required to conduct training for all employees and contractors on environmental, social, and cultural concerns in the sale area.

- Protection of historic and archeological sites -- Lessees must conduct an inventory of traditional use sites in the area proposed for activity and ensure that archaeological resources are preserved. Lessees must include in any development plan, a program to educate oilfield workers about community values, customs, lifestyles, and laws protecting cultural resources in the sale area.

6. Effects on Water Quality

Water quality throughout the sale area varies seasonally with changes associated with streamflow. Mean annual peak runoff occurs from late May to early July during and after break-up, and elevated turbidity and suspended sediment levels are common during these months. Natural as well as man-made contaminants can result in exceedences of water quality criteria. Natural contaminants to fresh water supplies include dead fish, birds, and animals; mosquito and insect larvae; algae and other plants; bacteria; parasites such as Giardia; silt and glacial flour; arsenic, iron, manganese; and hydrogen sulfide gas (AEIDC, 1975).

Water quality characteristics which may be altered by post-sale activities include pH, total suspended solids, organic matter, calcium, magnesium, sodium, iron, nitrates, chlorine, and fluoride. Potential impacts which may alter surface water quality parameters of the sale area include accidental spills of fuel, lubricants or chemicals; increases in erosion and sedimentation causing elevated turbidity and suspended solids concentrations; and oil spills (Parametrix, 1996).

The extent and duration of water quality degradation resulting from accidental spills depends on the type of product; the location of the spill; volume; season and duration of the spill or leak; and the effectiveness of clean-up response. Heavy equipment, such as trucks, tracked vehicles, aircraft, and tank trucks commonly use diesel fuel, gasoline, jet fuel, motor oil, hydraulic fluid, antifreeze, and other lubricants. Spills or leaks could result from accidents, such as during refueling, or from corrosion of lines (Parametrix, 1996). Under standard ADNR permit conditions for off-road activity, fuel and hazardous substances must have secondary containment apparatus. A secondary containment or surface liner must be placed under all container or vehicle fuel tank inlet and outlet points. Appropriate spill response equipment must be on hand during any transfer or handling of fuel or hazardous substances. Vehicle refueling is prohibited within the annual floodplain or tidelands (ADGC, 1995). Impacts of oil spills are discussed in Chapter Six.

The federal Clean Water Act established the National Pollutant Discharge Elimination System (NPDES) to permit discharges of pollutants into U.S. waters by "point sources," such as industrial and municipal facilities. In Alaska, the U.S. Environmental Protection Agency issues NPDES permits, designed to maximize treatment and minimize harmful effects of discharges as water quality and technology improvements are made. ADEC certifies that these discharge permits will not violate the state's water quality standards.

The Alaska Department of Environmental Conservation issues industrial and municipal wastewater permits, and monitors wastewater discharges and the water quality of waterbodies receiving the discharges. ADEC certifies federal wastewater permits with mixing zones that allow industrial and municipal facilities to meet state water quality standards. Industrial and municipal wastewater facilities are inspected annually. ADEC also certifies U.S. Army Corps of Engineer dredge and fill permits in wetlands and navigable waters to ensure compliance with state water quality standards, and provides technical assistance for design, installation, and operation of industrial and municipal wastewater systems.

Mitigation Measures

Several mitigation measures and lessee advisories serve to protect water quality from post-sale oil and gas activities. The following are summaries of some applicable mitigation measures. For a complete, full text listing of mitigation measures and advisories, see Chapter Seven.

- Tundra protection -- Winter and summer off-road vehicular traffic is restricted and must be approved in plan of operations.

- Wetland and Riparian Protection -- Lessees must avoid siting facilities in key wetlands and identified sensitive habitat areas. Onshore facilities other docks, or road and pipeline crossings, will not be sited within 500 ft. of fishbearing streams. Permanent facility siting is prohibited within one-half mile of the banks of major rivers.

- Water Conservation -- Removal of water from fishbearing rivers, streams, and natural lakes shall be subject to prior written approval by DMWM and ADF&G.

- Turbidity Reduction -- Exploration facilities, with the exception of artificial gravel islands, must be temporary and must be constructed of ice. Gravel mining sites will be restricted to the minimum necessary to develop the field efficiently and with minimal environmental damage and must not be located within an active floodplain of a watercourse. Causeways and docks may not be located in river mouths or deltas.

- Drilling Waste -- Underground injection of drilling muds and cuttings is preferred method of disposal. For onshore development, produced waters must be injected. Surface discharge of drilling wastes into waterbodies and wetlands is prohibited. Discharge of produced waters in marine waters less than 10 m deep is prohibited. Unless authorized by NPDES or state permit, disposal of wastewater into freshwater bodies, including Class III, IV, VI, and VIII wetlands, is prohibited.

- Oil Spill Prevention and Control -- Lessees are advised they must prepare contingency plans addressing prevention, detection, and cleanup of oil spills. Pipelines must be designed and located to facilitate clean-up. Buffer zones of not less than 500 ft. will be required to separate onshore oil storage facilities (with a capacity greater than 660 gallons) and sewage ponds from freshwater supplies, streams, and lakes and key wetlands

7. Effects on Air Quality

Air quality throughout the sale area is very good, with concentrations of regulated pollutants well below the maximum allowed under National Ambient Air Quality Standards designed to protect human health. In order to ensure that air quality standards are maintained, additional limitations on nitrogen dioxide, sulfur dioxide, and total-suspended-particulate matter are imposed on industrial sources under the provisions of the Prevention of Significant Deterioration Program, administered by EPA.

Routine activities associated with oil and gas exploration, development and production that are likely to affect air quality are emissions from construction, drilling and production. Air pollutants include nitrogen oxides (NOX), carbon monoxide (CO), sulfur dioxide (SO2), particulate matter (PM), and volatile organic compounds2 (VOC) (MMS, 1995, IV.B.1-92). Effects from VOC emissions would be insignificant because of the low potential for ozone formation. Photochemical pollutants such as ozone (03) form in the air from the interaction of pollutants in the presence of sunshine and heat. In the upper atmosphere ozone is beneficial because it absorbs solar ultraviolet radiation. In the lower atmosphere however, it is a strong oxidizing agent and can be harmful. There is a low potential for ozone formation in the sale area because the summer time air temperatures remain relatively low (MMS, 1996a, IV.B.1-94).

Emissions, such as engine exhaust and dust would be produced by trucks, heavy construction equipment and earth moving equipment. Emissions would be generated during installation of pipelines and utility lines, excavation and transportation of gravel, mobilization and demobilization of drill rigs, and during construction of gravel pads, roads, and support facilities. Elevated levels of airborne emissions would be temporary and would diminish after construction phases are complete. Emissions would also be produced by engines or turbines used to provide power for drilling, oil pumping, and water injection. In addition, aircraft, supply boats, personnel carriers, rollogon trucks, mobile support modules, as well as intermittent operations such as mud degassing and well testing would produce emissions (MMS, 1996a, IV.B.1-93).

Other sources of air pollution include evaporative losses (VOC) from oil/water separators, pump and compressor seals, valves and storage tanks. Venting and flaring could be an intermittent source of VOC and SO2 (MMS, 1995, IV.B.1-93). Gas blowouts, evaporation of spilled oil and burning of spilled oil may also affect air quality. Gas or oil blowouts may catch fire. A light, short-term coating of soot over a localized area could result from oil fires. However, soot produced from burning oil spills tends to slump and wash off vegetation in subsequent rains, limiting any health effects (MMS, 1995, IV.B.1-95).

Several kinds of atmospheric pollutants can be found in the Arctic including organic contaminants and pollutants associated with the burning of fossil fuels, smelting, and industry. There is increasing concern about these contaminants entering the Arctic food chain; a concern that researchers have been aware of since the 1970's. Most contaminants do not originate in the Arctic, but likely result from long-range transport from lower latitudes. The U.S. EPA has initiated a regional study to collect data on atmospheric contaminants which would complement other circumpolar nations' research efforts. Although there are published data on food chain contamination by DDT and radionuclides, there are little if any data on U.S. Arctic food web contamination from other sources (MMS, 1991).

Arctic haze is a generic term for pollutant-laden aerosols distributed throughout the polar regions in late winter and early spring. Arctic haze probably develops from both man-made contaminants reaching the Arctic from the south, and from pollutants originating from the industrialized Arctic. In late spring, these materials may be deposited on snow covered land masses. Brown snow events occur intermittently in the Arctic and are believed to be caused by industrial emissions from Asia (MMS, 1991). Despite the seasonal long-distance transport of contaminants into the Arctic, pollutant levels in the air above the sale area are still far below maximum allowable standards (MMS, 1996b:III-A-14).

It is not possible to predict at the lease sale stage the amount of pollutants produced. All industrial emissions in the Arctic U.S. must comply with the Clean Air Act (42 U.S.C. §§ 7401-7642) and state air quality standards. 18 AAC 50 provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria. 18 AAC 50.300 sets up standards for air quality at certain facilities, including oil and gas facilities, at the time of construction, operation, or modification. DO&G continues to search for, but has not found any evidence that fish or terrestrial mammal population declines are linked to industrial emissions emanating from existing North Slope oil and gas facilities. Federal and state statutes and regulations that will mitigate potential impacts air quality include:

- 42 U.S.C. §§ 7401-7642. Federal Clean Air Act
- AS 46.03. Provides for environmental conservation including water and air pollution control, radiation and hazardous waste protection.
- 18 AAC 50. Provides for air quality control including permit requirements, permit review criteria, and regulation compliance criteria.
- 18 AAC 50.300. Sets up standards for air quality at certain facilities including oil and gas facilities at the time of construction, operation, or modification.

ADEC's Air Quality Maintenance program controls significant, stationary sources of air contaminants to protect and enhance air quality and abate impacts on public health and the environment. The 1970 Clean Air Act established air quality programs to regulate air emissions from stationary, mobile and other sources which pose a risk to human health and the environment. ADEC monitors compliance with regulations and air quality standards through annual inspections and uniform enforcement procedures. The agency issues operating permits to existing major facilities incorporating all applicable requirements, and issues construction permits to new large facilities and for expansions of existing facilities.

C. Fiscal Effects

1. Statewide

Alaska's economy depends heavily on oil and gas related revenues and resultant government spending. Lease sales generate income to the state in five ways, as described below. Some of these-bonus payments, rentals, and to a certain extent, corporate income taxes-are generated for each lease sold, regardless of whether a discovery is ever made or production established.

- Bonus Payments. These are the amounts paid by winning bidders for the individual tract lease at a lease sale. Since 1959, 5,210 tracts have been sold, generating more than $2 billion in bonus bid income to the state.

- Rentals. Each lease requires an annual rental payment. The first year rent is $1.00 per acre or fraction of an acre, and the rent increases in 50¢ increments to $3.00 per acre or fraction of an acre in the fifth and all following years of the lease. The lessee must pay the rent in advance and receives a credit on the royalty due under the lease for that year equal to the rental amount. Rental income for fiscal year 1998 (July 1997 through June 1998) amounted to $4.9 million.

- Royalties represent the state's share of the production as the mineral interest owner. Royalty payments provided over $790 million in revenue to the state in fiscal year 1998

- Production taxes. All producers must pay tax on all taxable oil and gas produced from each lease or property in the state on a percentage-of-gross value basis. For fiscal year 1998, oil and gas production taxes were $607 million.4.

- Income taxes. All corporations in the state must pay corporate income tax for all taxable income derived from sources within the state. Special provisions apply to apportioning total income worldwide for corporations involved in producing or transporting oil and gas. Most, if not all, producers and transporters of oil and gas in Alaska are corporations. For fiscal year 1998, oil and gas corporation taxes were $185 million.

Together these revenues comprised approximately 75 percent of the state's general fund unrestricted revenue in fiscal year 1998. Such revenues finance the state's revenue sharing, municipal assistance, education funding, operating budget and capital budget. State spending supports nearly one out of every three jobs, and three of every ten dollars of personal income result from state spending. Nearly one of every two local government jobs (including school district jobs) in Alaska relies on state funding (ISER, 1990). Oil and gas royalties and revenues also contribute to the Alaska Permanent Fund, which pays significant dividends each year to every qualified state resident.

The Alaska Permanent Fund was established by ballot proposition in 1976. Fifty percent of all revenue generated by this lease sale (rentals, payments, and taxes) will be placed in the permanent fund. The state's oil-wealth savings account stood at $25.015 billion at the end on June 30, 1998 an increase from the previous year's $22.1 billion. All qualified Alaskans who apply, receive an annual dividend from the earnings of the permanent fund. In 1998, approximately $869 million was distributed under the program to an estimated 564,085 eligible Alaskans. Every qualified man, woman, and child in Alaska received a dividend check of about $1,541 (see Figure 5.4). The PFD is an equitable benefit transfer because it reaches every individual regardless of income or socio-economic status. The permanent fund continues to support Alaska families and the state economy.

Furthermore, the total economic effect of any spending, including state government spending and salaries paid to private oil and gas industry employees, is always greater than the direct effect. When money is re-spent in the economy, its original value multiplies. For example, this "income multiplier" is calculated at

1.35 for state spending. This means that for every dollar of income Alaskans receive directly from state spending, an additional 35 cents of income is generated when that dollar is re-spent in the local economy (ISER, 1990).

Figure 5.4 Alaska Permanent Fund Dividends

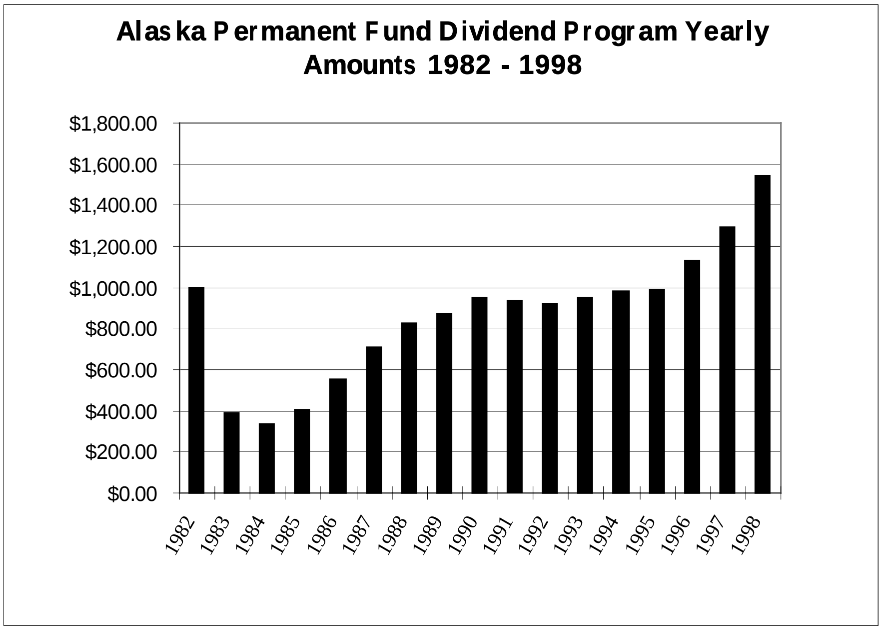
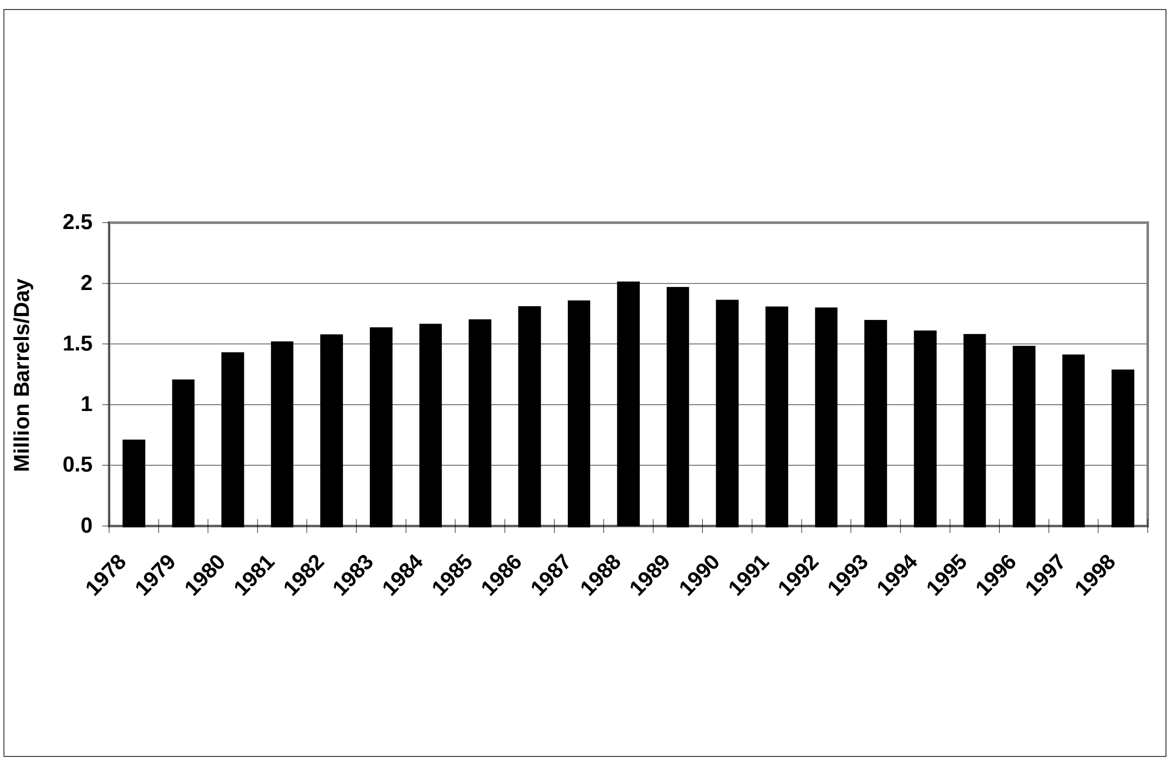


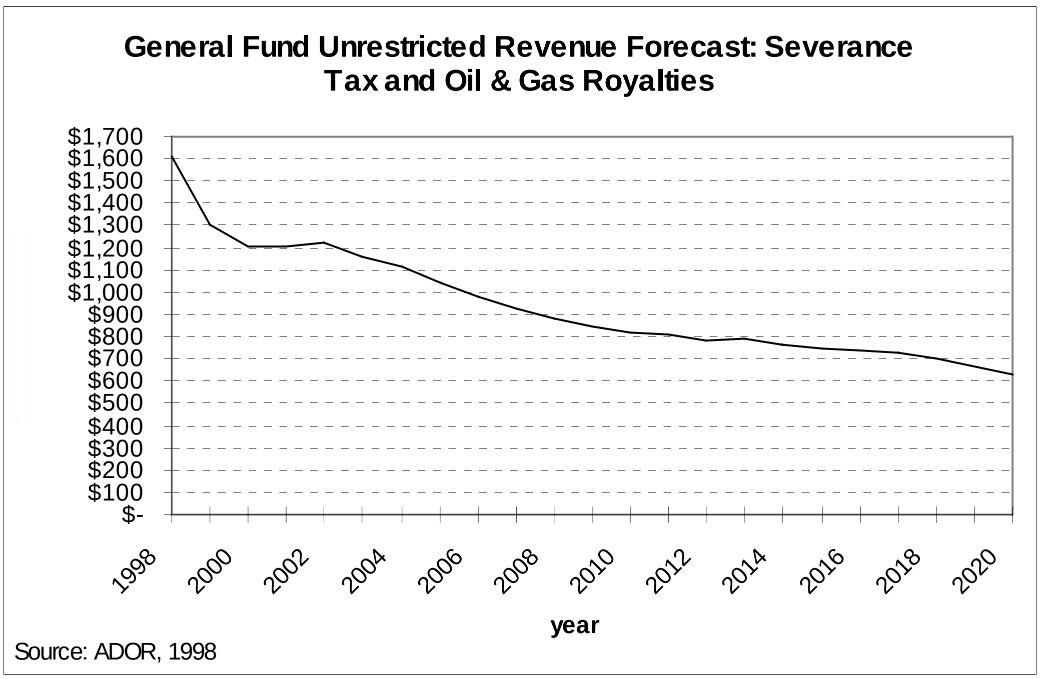
Figure 5.5 Historic Crude Oil Production



The primary source of state revenues is North Slope oil production. North Slope fields hold 98 percent of the state's known oil reserves and 90 percent of the state's known gas reserves. The remainder of state oil and gas reserves are found in Cook Inlet fields However, oil and gas reserves are finite resources and North Slope production is declining (See Figure 5.5).

North Slope oil production has declined by approximately 700,000 barrels of oil per day (bpd) from its peak of approximately 2.0 million bpd in 1988 to an estimated average of 1.27 million bpd in 1998. The overall decline will accelerate, and production is expected to fall to 990 million by 2005 and to 316 thousand bpd in 2010. Annual production from Cook Inlet fields has been declining for many years. Cook Inlet production now averages approximately 32,000 bpd, down from a peak of 227,200 bpd average in 1970. These declines in oil production cause corresponding decreases in related revenues and seriously impact state government income and spending.

Figure 5.6 Alaska Oil and Gas Severance Tax and Royalty Revenue Forecast



2. Local

Although some North Slope Borough funds are derived from revenue sharing programs with the state (Table 5.4), borough revenues are primarily generated from taxes on residential, commercial, and oil and gas properties. These revenues fund capital improvement projects and community services such as education, public safety, planning, and health care, and allow the borough to employ local residents (Table 5.5). In 1991, the NSB Assembly was able to repeal the sales tax as a result of an agreement by the major North Slope oil producers to pay the NSB an additional $5 million per year for five years.

Oil and gas production activities from existing discoveries already comprise a significant percentage of the NSB economy and tax base. Approximately 98 percent of the borough's property taxes come from assessments on the oil industry. However, the NSB is dependent on revenue tied to production from oilfields that are in decline. At present, it is facing a non-increasing revenue base. The 1996 assessment of property within the borough was approximately $11.7 billion, down from a peak value in 1987 of about $13.5 billion (NSB,1997). This includes the segments of TAPS (containing the first 177 miles of the pipeline, including support facilities) which lie within borough boundaries.

Table 5.4: State Revenue Sharing and State Spending FY 97

Municipality	Revenue Sharing	Other State Spending	Total
North Slope Borough	$343,215	$31,897,314	$32,240,529
Anaktuvuk Pass	$31,720	$45,820	$77,540
Atqasuk	$31,720	$46,783	$78,503
Barrow	$8,829	$215,287	$314116
Kaktovik	$31,317	$136,748	$482,181
Nuiqsut	$31,720	$13,366	$45,086
Point Hope	$31,317	$109,820	$141,137
Wainwright	$63,067	$17,344	$80,411

Source: ADCRA 1998

Table 5.5: North Slope Borough Employment Profile

NSB average monthly employment and earnings 1996.

Industry	Workers	Av. Monthly Earnings
Mining (Oil and Gas)	3,548	$6,741
Construction	344	$6,124
Trans/Comm/Utilities	428	$5,896
Retail Trade	524	$3,159
Services	890	$3,080
Federal Government	43	$3,584
State Government	57	$4,320
Local Government	2,286	$3,480
Finance, Insurance, Real Estate	143	*
Total:	8,263	

* Is used to avoid disclosure of data for individual firms.

Source: Alaska Department of Labor, 1994a.

In preparation for declining tax revenues, the NSB has established a permanent fund. Whenever the borough government's income exceeds expenditures, the surplus is added to the existing fund's investment base. For the fiscal year 1996-97 the value of the fund was approximately $361 million (NSB, 1997:80). Earnings from investments are earmarked to provide public services. In FY 1996-1997, the fund earned $48.4 million (NSB, 1997:vi).

The NSB economy, like all of Alaska, is heavily dependent on state spending. Government employment (federal, state, and local) accounts for 2,386 full time permanent jobs. Next to the oil industry, the NSB is the region's principal employer. Borough employment policies help ensure that local residents are hired for borough-funded community projects.

The NSB received over $11 million in state education foundation funding in FY 1998. Revenue sharing totaled $343,215 and other state revenue totaled $7,712,542 for FY 97. The Borough received $2,736,631 for capital projects in FY 1997(ADCRA, 1998). Alaska Permanent Fund Dividends provided approximately $11.4 million to borough residents in 1998.

As exploration takes place, and if development occurs, the sale would add jobs to the state and regional economy. These jobs would not be limited to the petroleum industry, but would be spread throughout the trade, service, and construction industries. However, the number of jobs produced would depend on whether commercial quantities of oil and gas are discovered. Discovery and development of commercial quantities of petroleum or natural gas in the sale area would bring direct economic benefits to the North Slope area in the form of additions to local property tax revenue.

D. Effects on Municipalities and Communities

1. Infrastructure

The communities most directly affected by the sale are Barrow, Nuiqsut, and Kaktovik. However, oil and gas exploration, development, production and transportation can have important effects on all North Slope communities. Such activities have already brought new job opportunities to the North Slope region in both industry and government through additional revenues. These activities have also heavily impacted the flow and sources of revenue for the NSB, resulting in improved infrastructure (public buildings and services) in each village in the borough.

2. Employment

As discussed under Fiscal Effects, the oil industry and the NSB are the region's two principal employers. There may be additional short-term job opportunities during the exploration phase. The long-term employment benefits of this sale in the NSB and local communities will depend on the subsequent production of commercial quantities of petroleum and local hire opportunities.

3. Local Tax Revenues

As discussed under Fiscal Effects, oil and gas activities could also provide direct benefits to the NSB by increasing the taxable property base. Significant revenues have been generated through taxing the oil industry, services, and support facilities. If commercial quantities of petroleum or natural gas in the sale area were discovered and developed, there would be direct economic benefits to the North Slope area in the form of additions to local property taxes.

4. Land Planning and Uses

a. Land Use Plans

The Borough has an approved coastal management plan. Provided proposed activities are conducted in a manner consistent with the coastal management plan, the NSBCMP does not prohibit oil and gas exploration and development, nor does the NSBCMP require revision to allow these activities.

b. Access

Local residents' use of the sale area depends on access to the area. Development of the sale area could adversely affect human uses of the area and its resources if access to hunting, fishing, or trapping areas is restricted or if industry activities occur at the same place and time as these activities. Conversely, development of the sale area could actually increase public access for users of the area's resources. If roads were constructed across general state lands, they would be open to the public and available for multiple use activities.

c. Recreation, including Fishing and Hunting

Subsistence activities, including hunting and fishing, are discussed in Chapter Four. There is low potential for interference with recreational hunting and fishing due to the timing of development or the placement of structures. Most recreation in the area would occur during summer, while development would occur during winter. If development occurs, consolidation of petroleum facilities would reduce conflicts with recreation users of the area. Consolidation benefits both the public and industry. The "visual, environmental, social, and economic effects are concentrated," and are "less complicated and less costly" (ADCRA 1978:31). Use of the sale area will be unrestricted, except when required within a radius of 1,500 ft. around onshore facilities or structures. If development occurs, there could be a small but unpredictable number of new hunters and fishermen from the potential increase in local population in the oilfields or at Deadhorse.

Mitigation Measures

The following are summaries of some applicable mitigation measures and lessee advisories. For the full text of mitigation measures and advisories, see Chapter Seven.

- Increased employment opportunities -- Lessees are encouraged to employ local and Alaska residents and contractors.

- Compliance with land use plans and coastal management plans -- all proposed activities must be reviewed for consistency with the approved state and district coastal management program standards. Lessees must involve local communities and interested local community groups in the development plans of operations.

- Unrestricted public access -- public access to leased land may only be restricted within the immediate vicinity of onshore drill sites, buildings, and other related structures.

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